Chemical Engineering

BER 16, 1957.

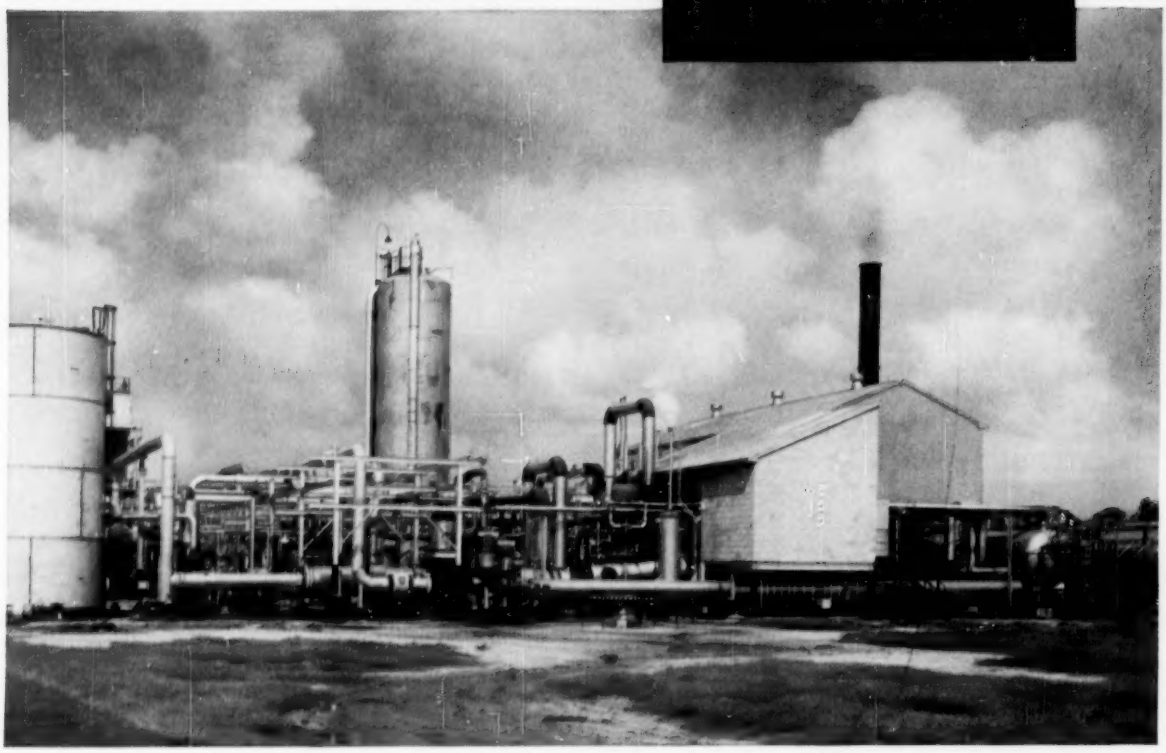
how to cope with a

WATER SHORTAGE

SEE PAGE 3

Girdler nitric acid plants employ the well-known Du Pont process, using high-pressure catalytic oxidation, to produce nitric acid. These plants offer greater economy, in both investment and operating costs, than atmospheric or low-pressure units. With the high-pressure process, 55%-60% nitric acid is produced with efficient use of catalysts, and with lower utility requirements.

NITRIC ACID



New Girdler nitric acid plant goes "on stream"

The new 250 ton per day nitric acid plant of Southern Nitrogen Company, Savannah, Georgia, shown above, was engineered and built by Girdler. This is one section of a Girdler plant designed to produce ammonia and convert it into nitrogen products.

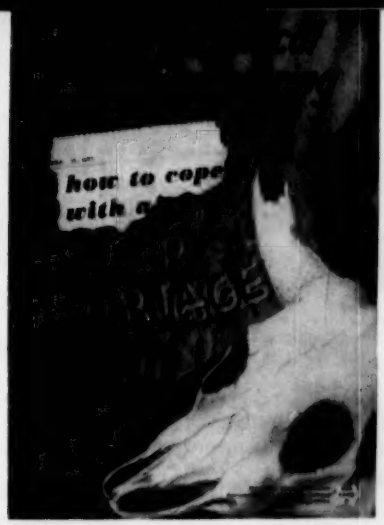
Girdler nitric acid plants employ the Du Pont process. Hence, when you come to Girdler for your nitric acid facilities, you get the combined know-how of Du Pont and Girdler . . . to assure minimum capital investment and operating costs. For complete information, call the nearest Girdler office today.

the GIRDLER Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY
GAS PROCESSES DIVISION . . . Offices: New York, San Francisco

DECEMBER 1957

JOHN R. CALLAHAM, Editor-in-Chief



Don't Be Surprised . . .

Don't be surprised if your January issue of CE doesn't come at its usual time. It'll be about two weeks later.

Reason, as we've already announced, is that in 1958 we swing to a 26-times-a-year frequency. You'll now receive a copy of CE every other Monday rather than once a month.

This means an entirely new printing and mailing cycle. You'll get your first 1958 issue, for example, within the period January 10-13, your second one January 25-27. Another issue will reach you every two weeks thereafter, regardless of dates or months.

We've been gearing up for this accelerated tempo for some time (see p. 4). Naturally we're all excited about the possibilities.

After you've looked over your first January issue—don't forget it'll arrive at a new time—I'm sure you'll be as enthusiastic as we are.

GUIDED TOUR

Eight possible solutions to a water-shortage problem

There probably are no sun-bleached bones around your plant. Our pictorial cover symbolizes a problem that's arising more and more frequently. A panel of experts shows how water-shortage problems can be tackled. Their eight solutions should have ideas that may be translated into dollar savings and water conservation for you. (p. 237)

Borohydride by the ton

Vital link to high-energy fuels, sodium borohydride is now in volume production: "several tons per day." Lower costs promise greater commercial application of this effective reducing agent. (p. 146)

Wide-angle picture of petrochemicals

No longer stepchildren, the petrochemicals are an accepted part of the chemical

Chemical

GUIDED TOUR

family. Their production, to the tune of $4.5 billion, makes them an important part of our economy. (p. 206)

A prediction pans out

Twenty-year-old equation used to find friction factors has, as predicted, been proved. It appears to be accurate for pipeline design with Reynolds numbers as high as 40 million. (p. 253)

How to evaluate ion exchange

Rule-of-thumb is useless in separation problems. They're best tackled via pilot-plant data. Here's some background for sizing up ion exchange: what it can do, what it costs, and how it compares. (p. 255)

The pros & cons of overseas jobs

Six very real advantages come with a career job overseas. How would you line them up against the disadvantages? Now you can decide for yourself how you'd like to be working abroad. (p. 313)

CE is edited for the engineer concerned with chemical operations, whatever his function . . . administration, production and plant operations, design and construction, research and development, sales and purchasing. More engineers subscribe to CE than to any other magazine in the field. Print order of this issue:

47,154

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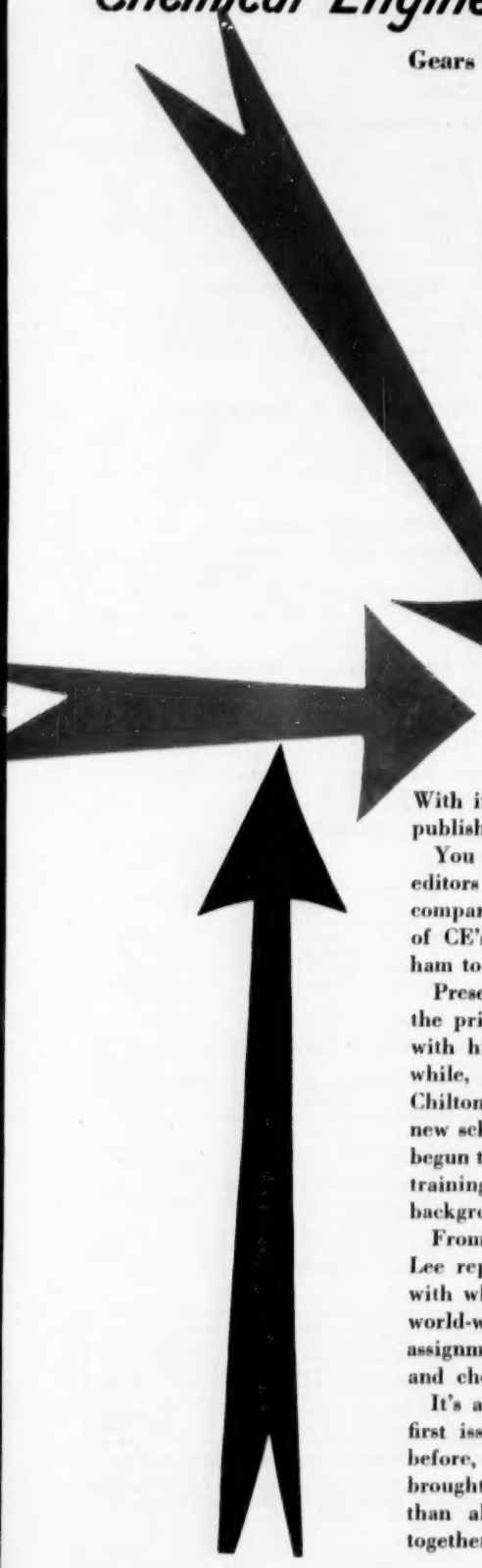
Chemical Engineering

Gears Up For Its



New Publishing Schedule

With its next issue Chemical Engineering will come to you on a new publishing schedule—every other Monday, instead of once a month.

You can get some idea of what this frequency change means to CE's editors by imagining what your own workload would be like if your company decided to double production in one giant step. The whole of CE's 22-editor staff is involved—from Editor-in-Chief John Callaham to Chuck Van Soye, newly hired editorial assistant.

Presentation and Production Editor Les Pope has spent hours with the printer ironing out printing and mailing schedules, and working with his staff on new copy-processing methods to meet them. Meanwhile, Practices Editor Ted Olive and Developments Editor Cecil Chilton have discussed with their staffs the many ramifications of the new schedule and have alerted their authors. Ted and Cecil also have begun the big job of giving all our new editors a mighty dose of editorial training to go with their already strong engineering and industry backgrounds.

From San Francisco and Houston, field editors Emil Mikity and Jim Lee report that they have lined up several top-flight feature articles with which to kick off the new year. And staff men in McGraw-Hill's world-wide network of news bureaus are racing the clock to complete assignments covering all aspects of chemical engineering technology and chemical process industry operations.

It's a big job, but it's moving forward on schedule. You'll get the first issue January 13th, subsequent ones every second Monday. As before, they'll be authoritative, they'll talk your language. They'll be brought to you by a publishing staff which includes more engineers than all other chemical process industry technical magazines put together.

This issue's 10 top features of significance in

Petrochemicals & Petroleum Refining

Hot competition for petroleum fuels 146

New unit means tonnage turnout of sodium borohydride—key intermediate to boron-based, high-energy fuels.

Try this ingenious route to process steam 160

This two-stage, low-pressure steam generator simplifies scale-removal headaches, gleans operation savings too.

Butyl producers lick tough heat problems 180

One new butyl resists 400 F., excels other rubbers; while another—for tires—passes Army heat buildup tests.

Petrochemicals: No longer a chemical stepchild 206

They've developed to the point where they account for 25% of all chemical output. This month: methane derivatives.

What would you do about a water shortage? 237

If your petrochemical plant faced an acute water shortage, how would you cope with it? Here are 8 practical ideas.

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How to derive entropy and enthalpy, how to compare methods . . . plus data for these process design essentials.

Add these to your design reference file 275

Here are some good design references: on instrumentation, refrigeration, illumination, structural engineering.

Can you handle plastic process pipe? 300

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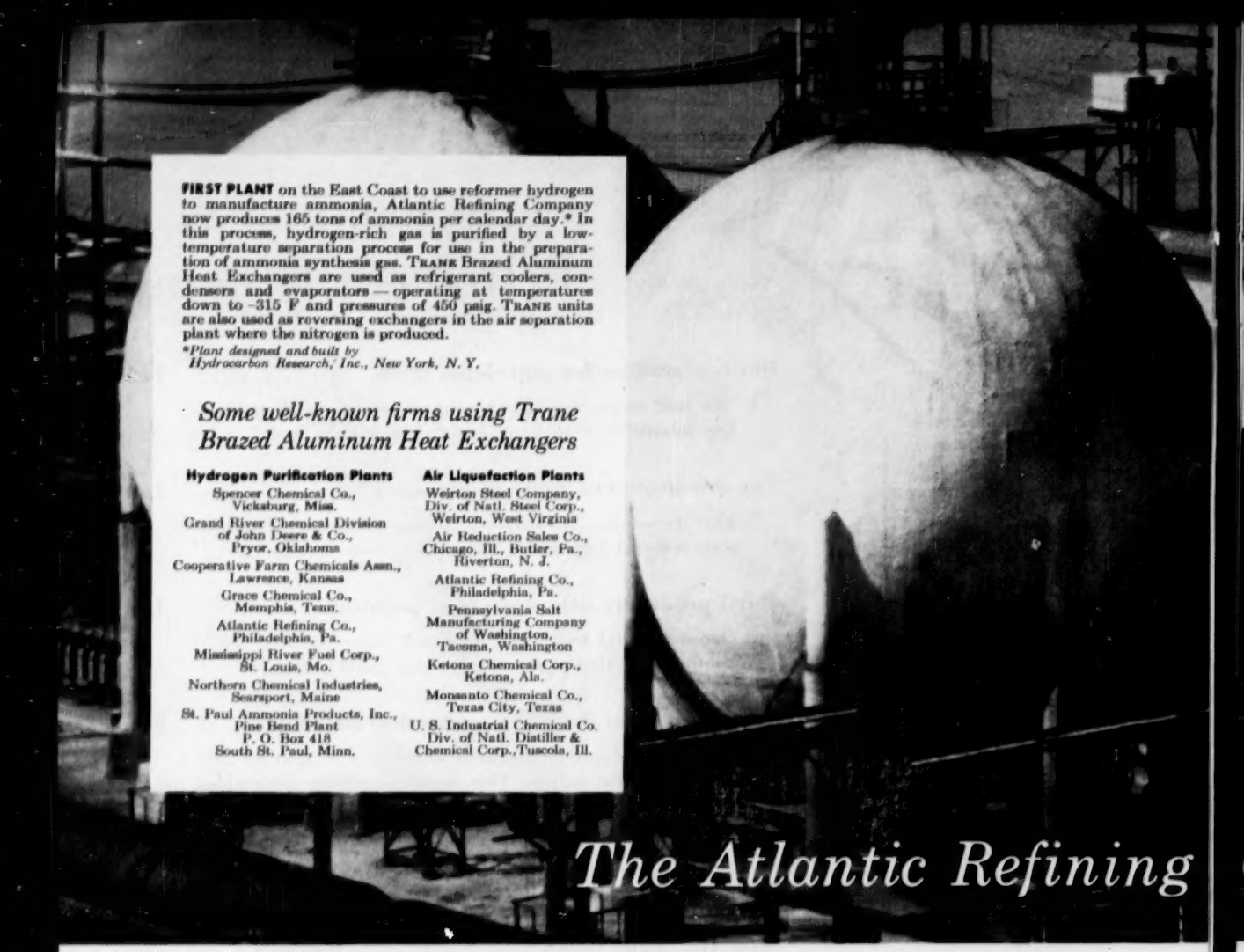

FIRST PLANT on the East Coast to use reformer hydrogen to manufacture ammonia, Atlantic Refining Company now produces 165 tons of ammonia per calendar day.* In this process, hydrogen-rich gas is purified by a low-temperature separation process for use in the preparation of ammonia synthesis gas. TRANE Brazed Aluminum Heat Exchangers are used as refrigerant coolers, condensers and evaporators — operating at temperatures down to -315 F and pressures of 450 psig. TRANE units are also used as reversing exchangers in the air separation plant where the nitrogen is produced.

*Plant designed and built by Hydrocarbon Research, Inc., New York, N. Y.

Some well-known firms using Trane Brazed Aluminum Heat Exchangers

Hydrogen Purification Plants

Spencer Chemical Co., Vicksburg, Miss.

Grand River Chemical Division of John Deere & Co., Pryor, Oklahoma

Cooperative Farm Chemicals Assn., Lawrence, Kansas

Grace Chemical Co., Memphis, Tenn.

Atlantic Refining Co., Philadelphia, Pa.

Mississippi River Fuel Corp., St. Louis, Mo.

Northern Chemical Industries, Searsport, Maine

St. Paul Ammonia Products, Inc., Pine Bend Plant P. O. Box 418 South St. Paul, Minn.

Air Liquefaction Plants

Weirton Steel Company, Div. of Natl. Steel Corp., Weirton, West Virginia

Air Reduction Sales Co., Chicago, Ill., Butler, Pa., Riverton, N. J.

Atlantic Refining Co., Philadelphia, Pa.

Pennsylvania Salt Manufacturing Company of Washington, Tacoma, Washington

Ketona Chemical Corp., Ketona, Ala.

Monsanto Chemical Co., Texas City, Texas

U. S. Industrial Chemical Co. Div. of Natl. Distiller & Chemical Corp., Tuscola, Ill.

The Atlantic Refining

450 psig operating Trane Brazed Aluminum

Flexibility, compactness, close temperature control aid economical production of high purity ammonia

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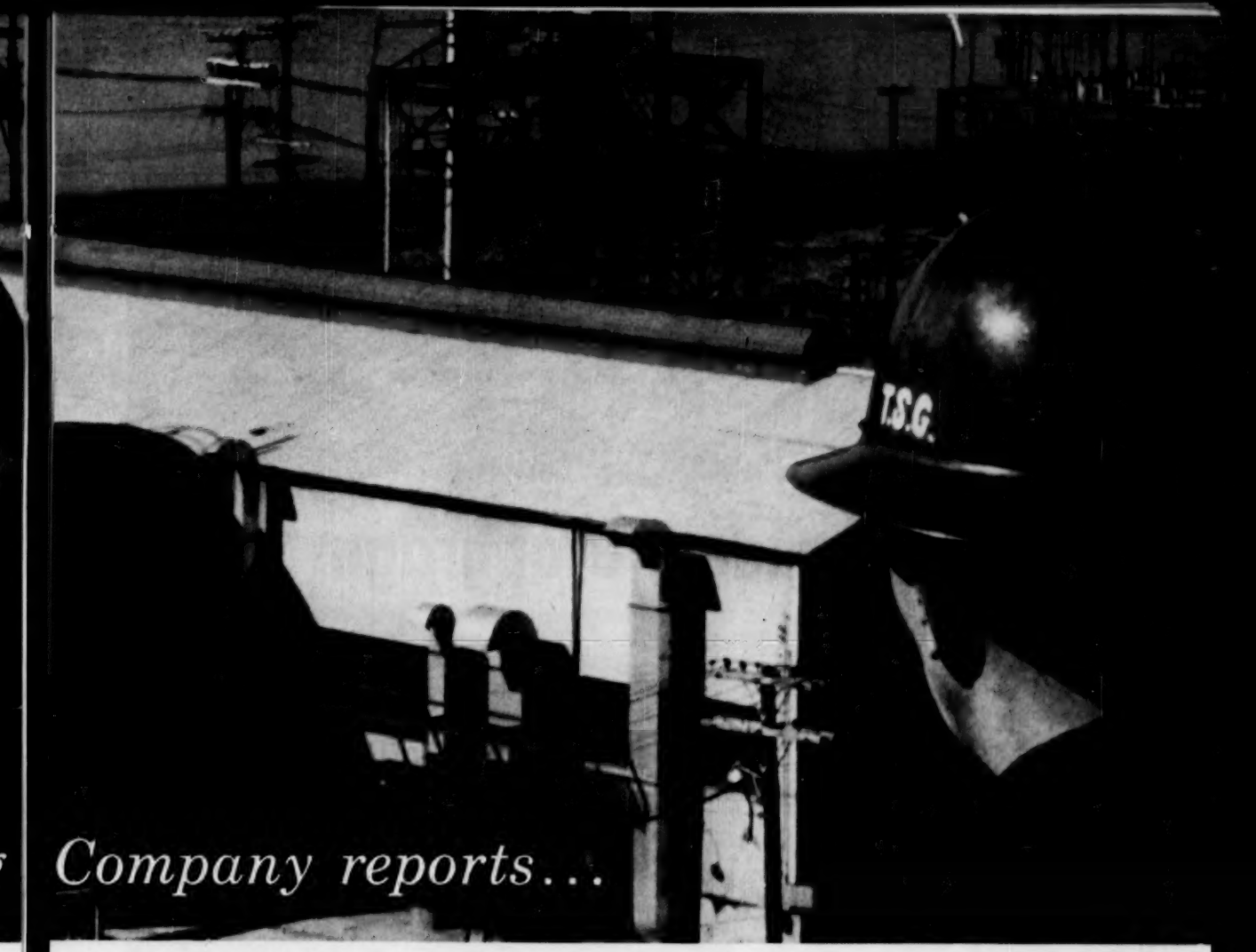
More and more modern low temperature gas separation plants are relying on TRANE Brazed Aluminum Heat Exchangers. Lightweight, compact and efficient, these Exchangers help reduce costs, while maintaining high production standards. If you have a heat transfer problem involving low temperatures, multi-stream operation or close approaches, turn to TRANE! Ask your nearby TRANE Sales Office, or write direct to TRANE, La Crosse, Wisconsin.



Company reports...

pressure at -315 F...with Heat Exchangers!

COLD BOX contains more than fifty TRANE Heat Exchangers. These lightweight exchangers consist essentially of alternate layers of corrugated aluminum sheets between flat plates, making it possible to obtain low temperatures with an economical minimum of equipment.

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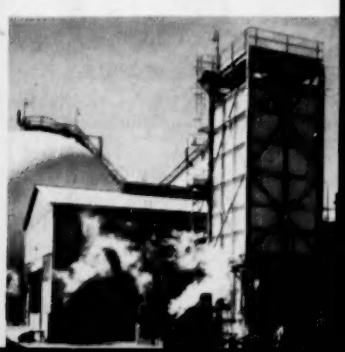

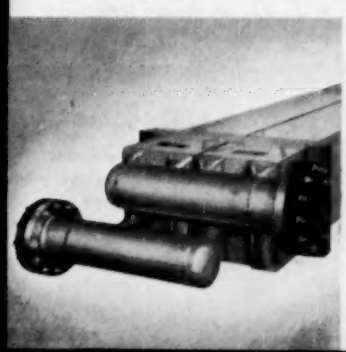

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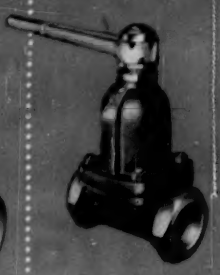

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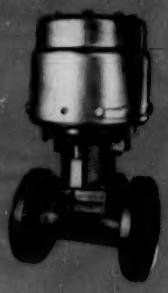

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Bonnets — iron; stainless steel; bronze; other materials on special order

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- diaphragm presses tight for positive closure
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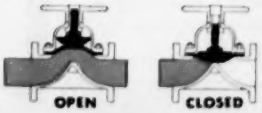

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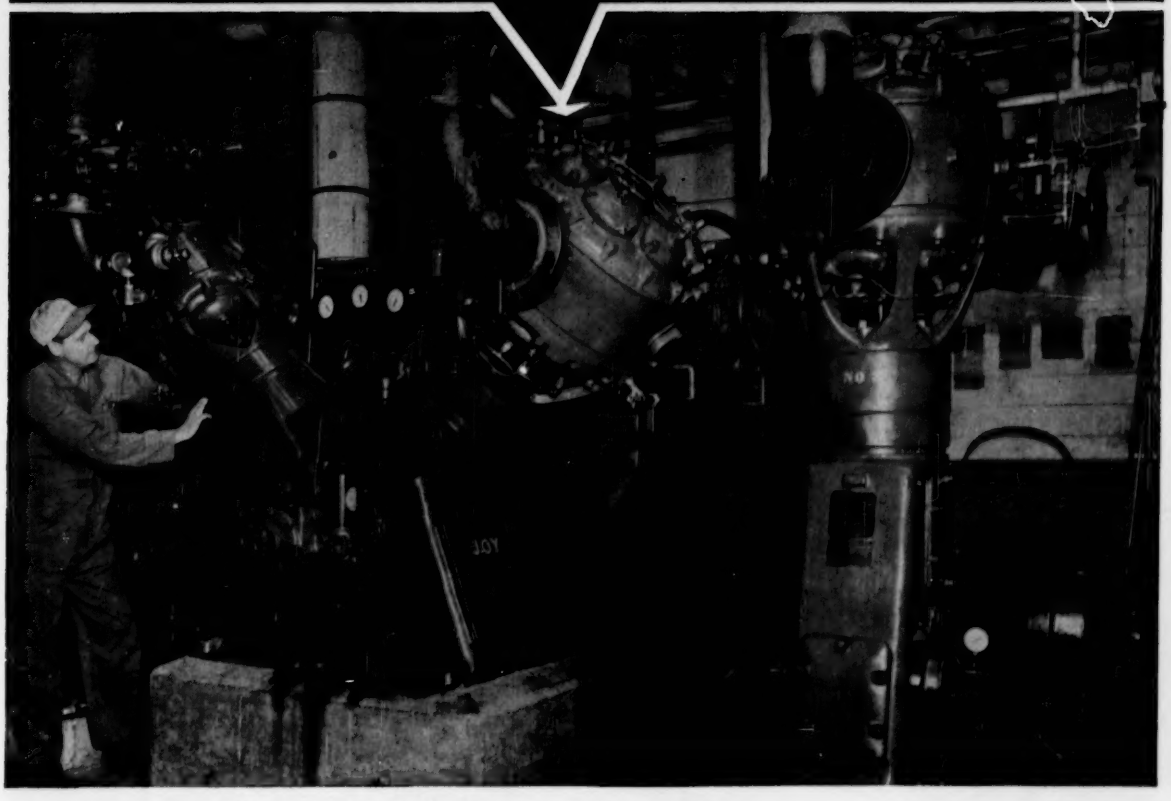

A West Coast Company needed more oil-free compressed air . . . in a hurry! However, there just wasn't any space in the boiler room for additional machines. They had been operating two Joy WG-9 OL vertical compressors (the machine at right in the photo). These non-lubricated compressors had run continously . . . 24 hours a day . . . for *17,000 hours with no down time.*

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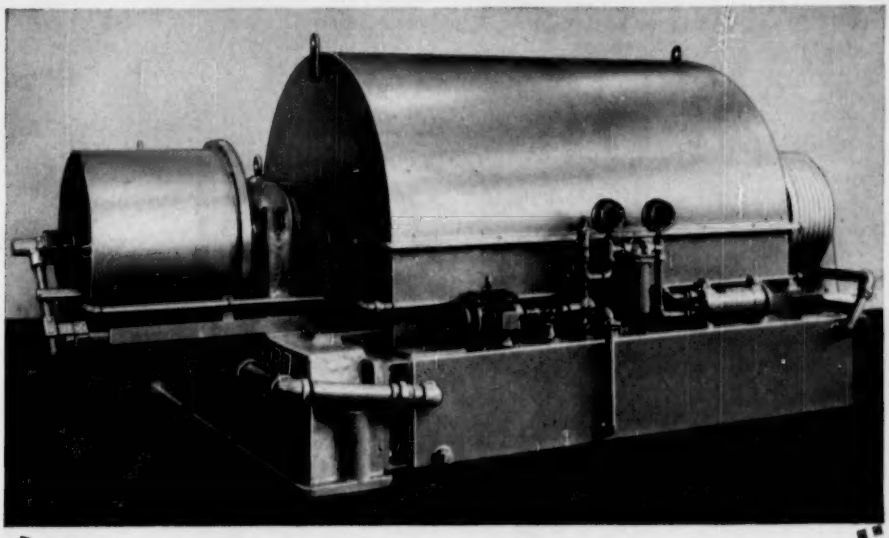

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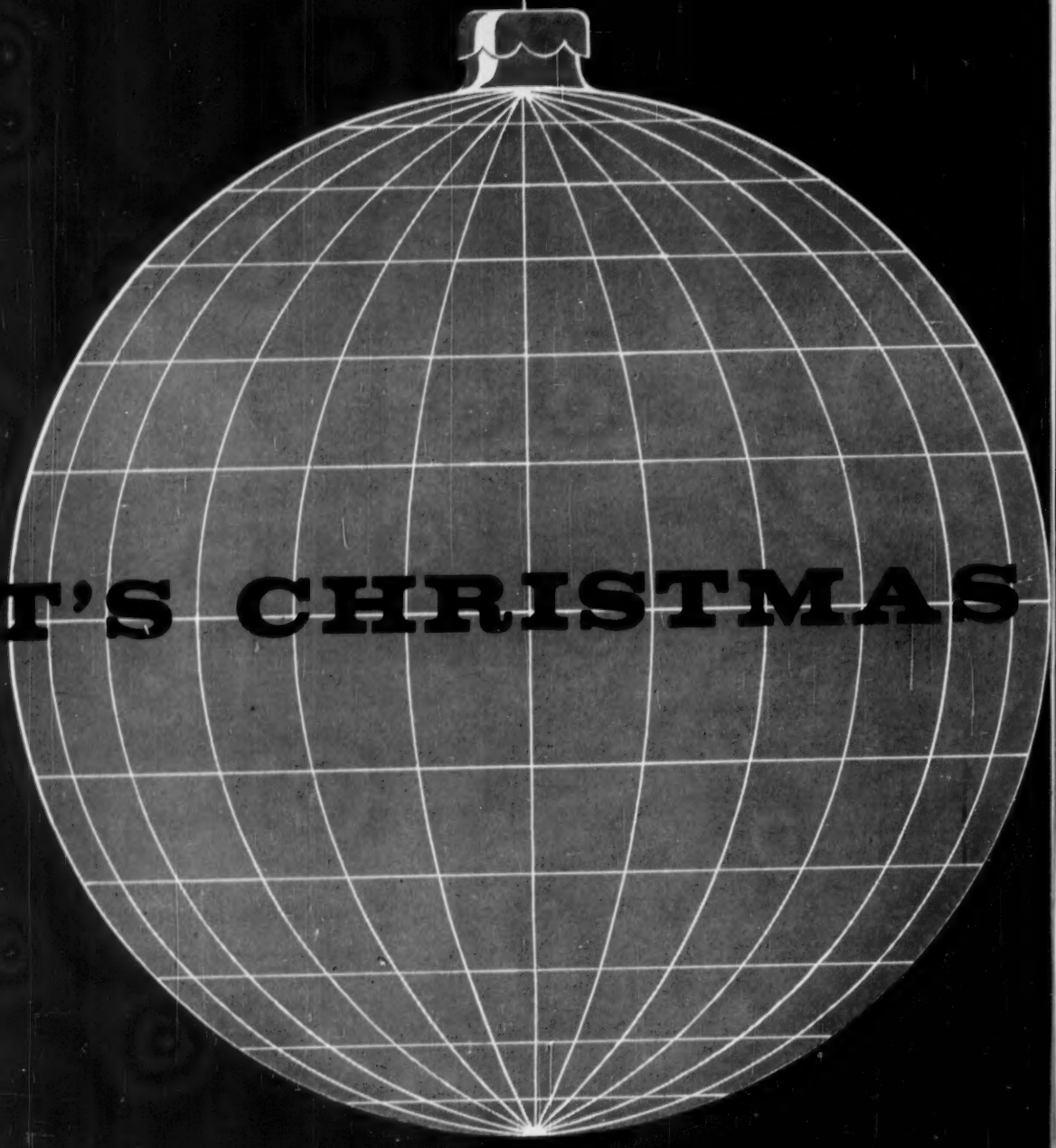

IT'S CHRISTMAS

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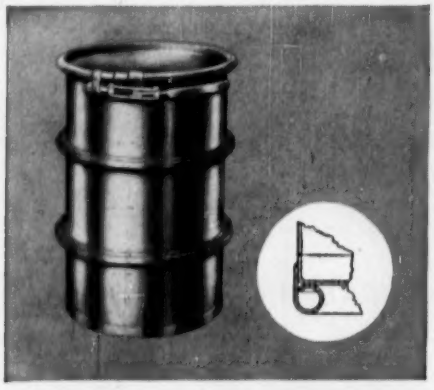
With smooth, crack-free bottoms, reinforced by special welded chimes, Hackney stainless steel drums clean easier, save more on maintenance costs.

Whether storing or shipping foods or other products, corrosion-resistant stainless steel guards against all contamination. Durable yet lightweight, these drums cut shipping and handling costs in a hurry.

Available in 30-, 50- and 55-gallon capacities. Equipped with a single bolt type or a quick-acting Toggle-tite clamp closure to provide a liquid-tight returnable drum.



Special Hackney welded chime is easy to clean, strong and durable. I-bar hoops eliminated when a straight side container is required. Nickel or Monel drums available upon request.

SEE US AT THE CHEM SHOW . . . BOOTH 631

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Manufacturer of Hackney Products

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Branch offices in all principal cities

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

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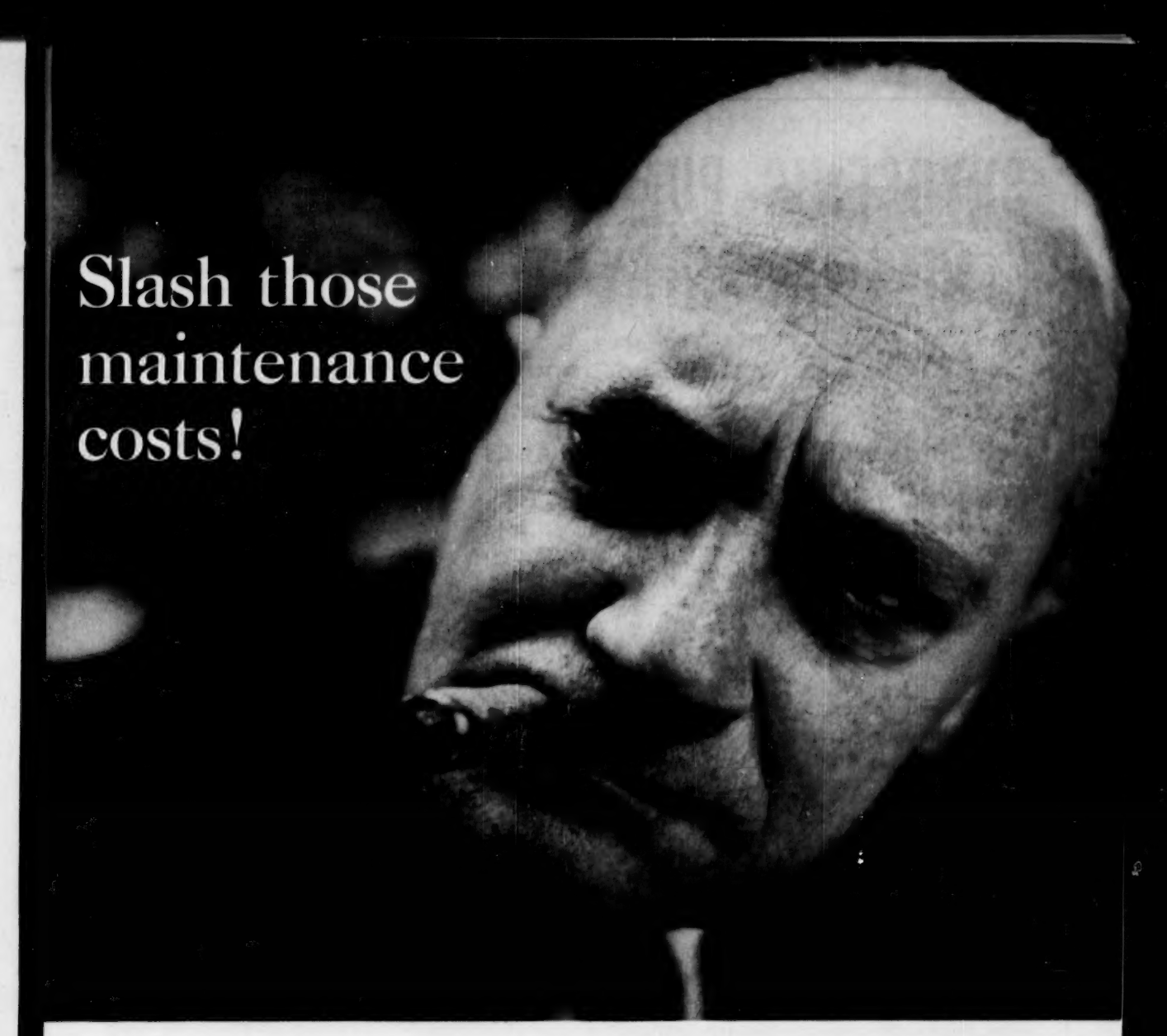

try titanium now!

Mounting competitive pressure makes reduced maintenance costs essential. More and more companies are easing this pressure with titanium—now readily available. Only titanium combines unique corrosion resistance with high strength-weight-ratio and works equally as well in valves and pipes as in complex components.

But there are even more compelling reasons for trying titanium *now*. Its strength and lightness can affect the size, performance and durability of equipment. It takes *continuous* temperatures up to 800 deg. F. and flash heats up to 2,000 deg. F., where other metals lose strength rapidly above 250 deg. F.

These or other characteristics of titanium could well be the answer to your most puzzling maintenance or production problem. Only by putting it to work on your process can you discover all the benefits that titanium can bring to you. Try it and see!

GET UP-TO-DATE ON TITANIUM

Booklet gives cost saving service records. Tells where you can get titanium mill products and fabricated equipment now.

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Division of Union Carbide Corporation
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Please send me a copy of "New Heat on Titanium."

*Name*_____

*Company*_____

*Address*_____

CRYOGENIC PUMP IS NOTEWORTHY NEW INDUSTRY DEVELOPMENT

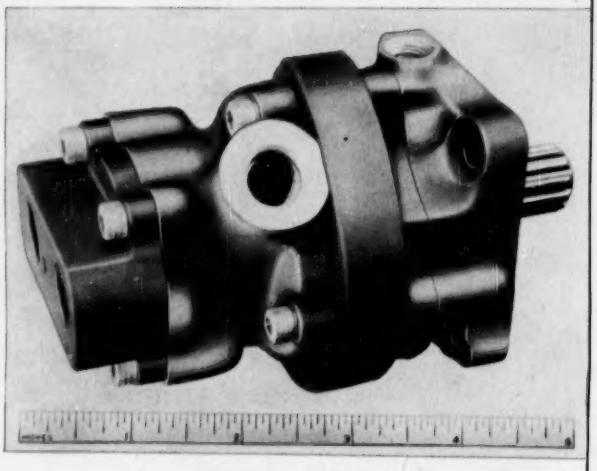
A product of Sundstrand-Denver, it has a demonstrated capability of pumping liquid nitrogen at pressures over 3000 psi at speeds of over 3500 RPM.

Piston type, extremely compact and lightweight, it has been under experimental development for a year and is suitable for pumping liquid gases such as nitrogen and oxygen. Sustained operating periods have been obtained repeatedly without any form of lubrication.

The pump is a design modification of a Sundstrand hydraulic motor which is made in many sizes and thus other larger capacity pumps can be provided with relatively little development.

The pump shown here has nine axial pistons and is of fixed displacement type. Metal parts have been selected to be compatible with liquid nitrogen. Minor material changes can be incorporated for satisfactory operation with the use of liquid oxygen.

The result of precision engineering and careful testing, these pumps appear to be the solution to many of the high power-to-weight problems encountered with missiles, rockets and high performance fighter planes; and, will prove highly useful for aircraft cooling systems and ground support equipment. Variation in orientation, size, mounting and assembly of these self-contained units can be supplied to suit your individual needs. For further information on using these pumps to solve your cryogenic pumping problems contact:



PERFORMANCE DATA
SUNDSTRAND-DENVER CRYOGENIC PUMP

Displacement	0.130 cu. in./rev.
Capacity @ 3500 RPM	1.75 gpm
Horsepower @ 3500 RPM	3.8 HP
Volumetric Efficiency @ 3000 PSI	90%
Weight	2.5 lbs.
AND Mounting Flange	10260 Type X
Dwg. No.	ED699

APPLICATION ENGINEERING DEPARTMENT

SUNDSTRAND-DENVER

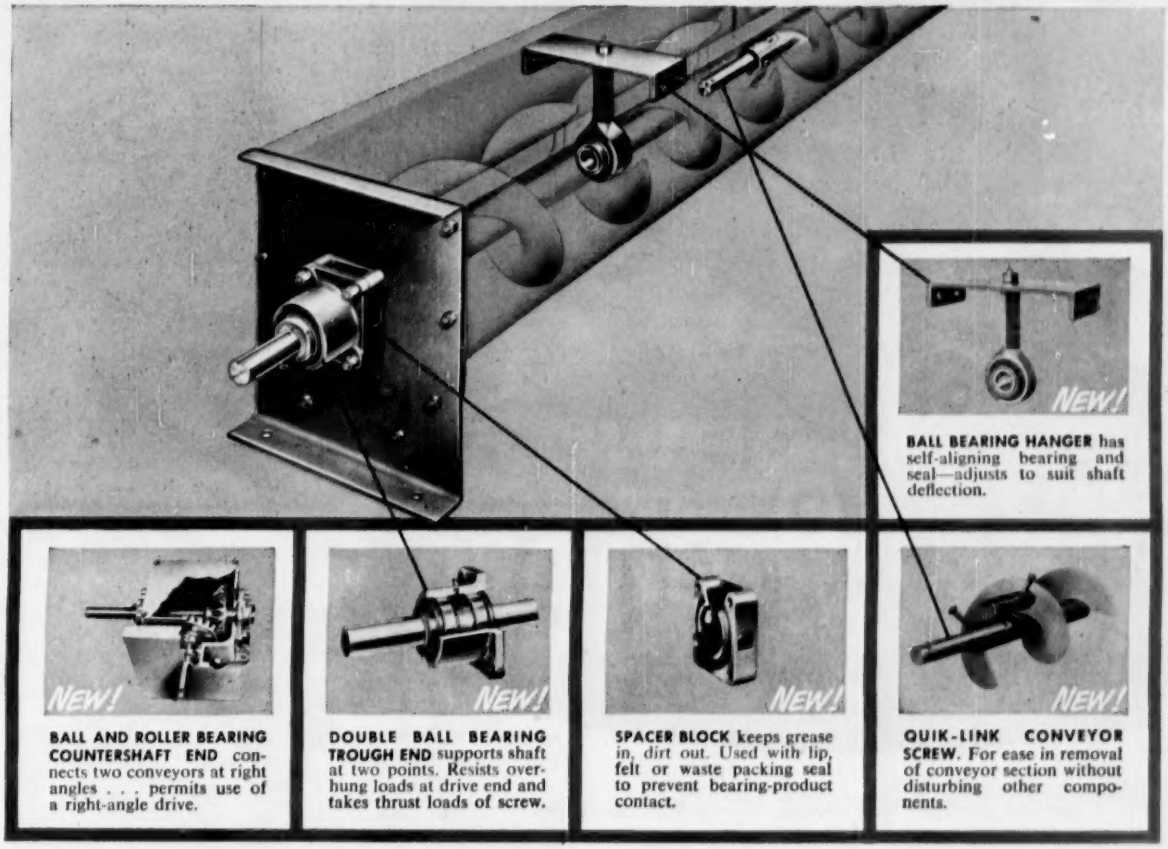
2480 W. 70th Avenue • Denver 21, Colorado

A DIVISION OF SUNDSTRAND MACHINE TOOL COMPANY

Complete design, development and precision manufacturing facilities

Why screw conveyors with

NEW LINK-BELT components demand less hp, less upkeep



BALL BEARING HANGER has self-aligning bearing and seal—adjusts to suit shaft deflection.

BALL AND ROLLER BEARING COUNTERSHAFT END connects two conveyors at right angles . . . permits use of a right-angle drive.

DOUBLE BALL BEARING TROUGH END supports shaft at two points. Resists overhung loads at drive end and takes thrust loads of screw.

SPACER BLOCK keeps grease in, dirt out. Used with lip, felt or waste packing seal to prevent bearing-product contact.

QUIK-LINK CONVEYOR SCREW. For ease in removal of conveyor section without disturbing other components.

For new or existing systems... LINK-BELT offers a complete line of accessories—many featuring ball and roller bearings

HERE'S a complete line of screw conveyor components designed to bring you smoother performance—reduce downtime and maintenance. Countershaft ends, as well as new trough ends and hangers, use Link-Belt precision ball and roller bearings to reduce starting and running friction . . . lower power requirements for all types of conditions.

The new trough end spacer block with seals protects bearings — prevents product contamination by grease and other foreign matter. Spacer is rabbeted for perfect alignment with bearings. Another outstanding refinement is the Quik-Link conveyor screw that makes removal of conveyor section possible without disturbing other components.

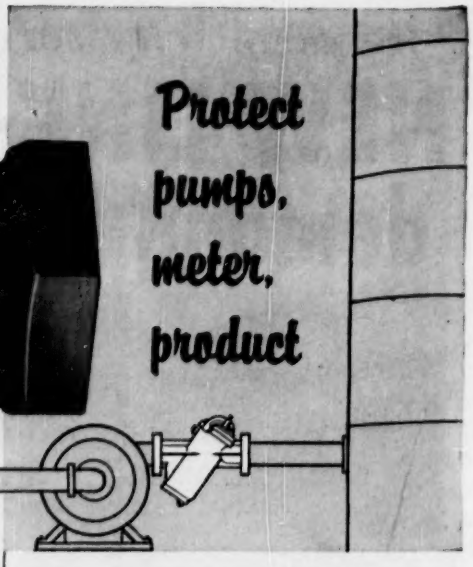
For facts, call your nearby Link-Belt office or authorized stock-carrying distributor. Or write for a copy of Folder 2489 today.

LINK-BELT

SCREW CONVEYORS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,701

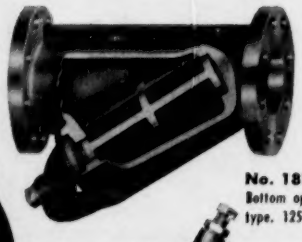
A Contamination-Free Product



No. 187
Bottom Outlet Type

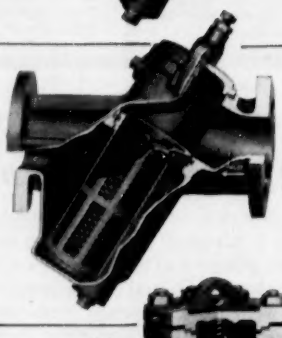
WITH **OPW**

line strainers

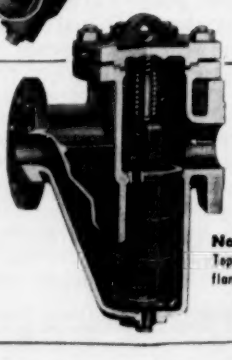


No. 187-F
Bottom opening
type. 125 pound.

No. 387
Top outlet type.
125 pound.



No. 387-F
Top outlet type
flanged. 125 pound.



No. 487-F
Top outlet type
flanged. 200 pound.

Is your product clean enough, your pump, meter and loading valve protected against scale, grit, dirt, rust and other foreign materials?

Be sure! Install OPW Line Strainers in any pipe line system for a cleaner product. Tight fit of cage and screen assures all product passing through strainer. Screen areas are many times pipe size for full flow. The simplicity of screen removal, cleaning and replacing facilitates regular, periodic checkup in the shortest possible time.

Choose your size, type and mesh! 125-pound standard or 200-pound high pressure types. Bottom or top outlet cage, reinforced for sturdiness and precision fit. Screwed or flanged end. Flanges, bolts and gaskets to suit. Strainer meshes from 14 to 300.

SEND FOR FREE BULLETIN F-36

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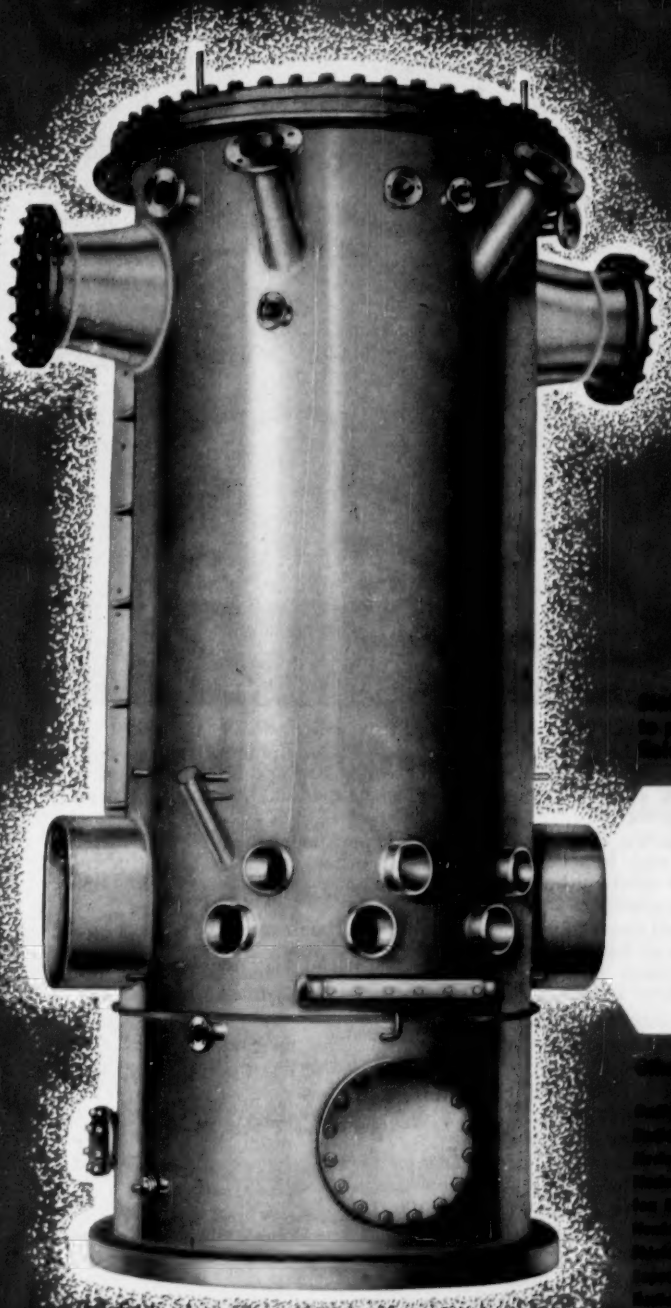

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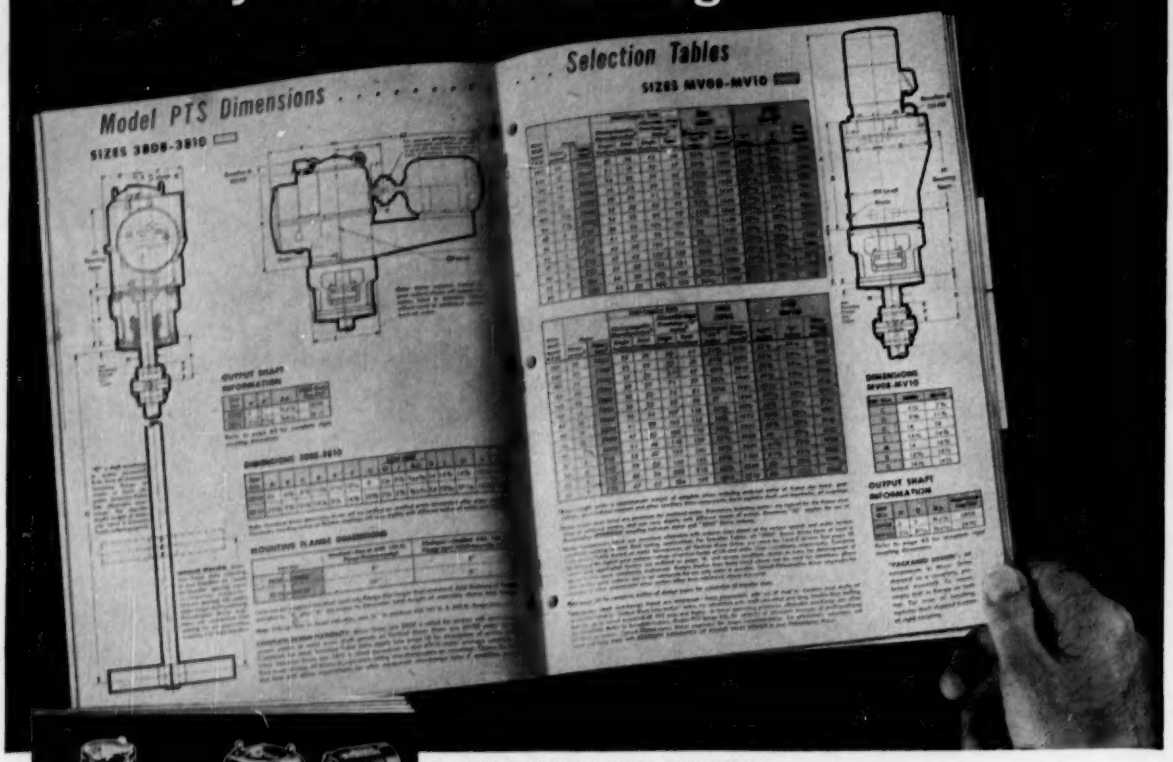

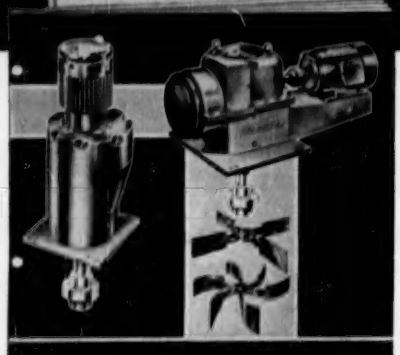

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Now for the first time—anywhere—Philadelphia Mixer presents easy-to-use, comprehensive mechanical design information permitting catalog selection of *complete* paddle and turbine type fluid mixers.

Choose the desired mixer drive type and size . . . correct lower shaft and impeller(s) . . . plus all other components including proper stuffing box or mechanical seal assemblies for pressure vessel mixing.

You will know exactly how much space the mixer drive will occupy on top of your tank . . . how much head room is necessary for an installation . . . what tank opening must be provided for insertion of mixing impellers . . . what mixer supports must be furnished.

SAVE TIME...

Determine the exact mixer assembly you need without unnecessary delay. No need to waste time and patience in lengthy consultation with outside sources.

REDUCE INSTALLATION COSTS...

Know early in your design project the required space for mixer installation and what room is available for other equipment. Avoid costly changes at a later date.

BE SURE OF CORRECT MIXER DESIGN...

Again, for the first time, *you* can select a complete mixer and be absolutely sure that it is a guaranteed sound, practical design which will assure optimum mixing performance.

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Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS
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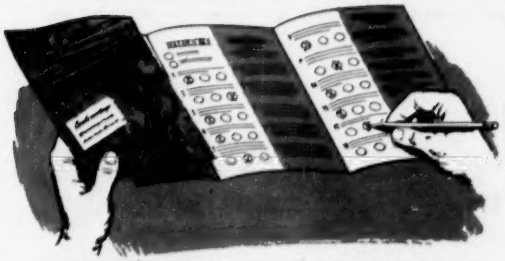
Stop explosions before they blow

Send for the CROUSE-HINDS "Hazard Finder"



● The Hazard Finder will enable you to make a quick survey of the hidden probabilities of electrically-ignited explosions in your plant.

Let Crouse-Hinds equipment and technical assistance help you to prevent electrically-ignited explosions.

The more than 13,000 Condulet ® items in the Crouse-Hinds line, include the world's widest selection of explosion-proof and dust-tight electrical equipment. There are Condulet devices for every circuitry requirement, and for every hazardous area and condition. All backed by engineers and technicians thoroughly familiar with Article 500 of the National Electrical Code and its application to specific situations.

For a quick, general survey of probable dangers in your plant, send for the Hazard Finder. For technical discussion of specific areas and hazards, write for Crouse-Hinds bulletins which apply.

● Or for personal assistance, ask any of the offices listed below to send a Field Engineer.

FREE

CROUSE-HINDS CO.
Syracuse 1, N. Y.

I want to check my plant. Send me your Hazard Finder.

Name_____

Company_____ Title_____

Address_____

City_____ State_____

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

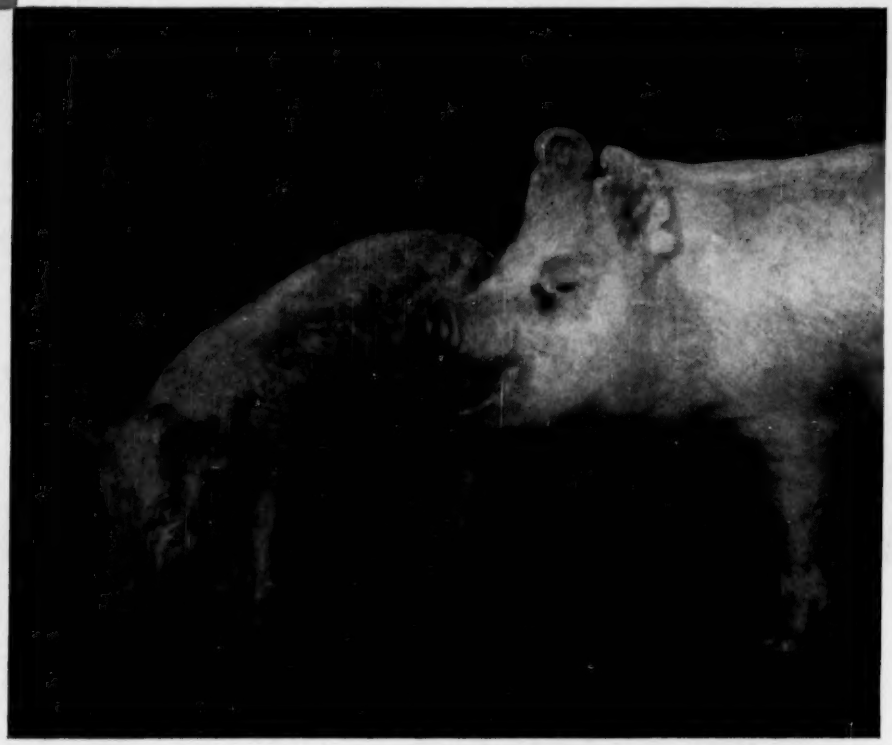
● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

A QUAKER OATS COMPANY CHEMICAL USE REPORT

Big this ~~little~~ pig thanks to

(Illustration Courtesy Hess & Clark, Inc.)



Infectious necrotic enteritis in swine is successfully combated with Nitrofurazone (5-nitrofurfural semicarbazone). Both pigs, shown above, were infected; both received the same ration except for medication. The pig on medicated feed gained 62 pounds in four weeks; the untreated one lost 15 pounds.

PHYSICAL PROPERTIES FOR PURE FURFURAL

Boiling point 764 mm, °C.	161.7
Melting point, °C.	-36.5
Flash point, tag open, cup, °F.	150-160
Specific gravity, 20/20 °C.	1.161
Refractive Index, n 20/D.	1.526
Ignition temperature, °C.	393
Viscosity, centipoises, 25° C.	1.49
Inflammability limits, lower, % at 125° C.	2.1

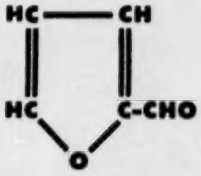
went to market
QO Furfural

The Quaker Oats Company does not manufacture Nitrofurazone, but supplies the QO furfural for its manufacture.

General Survey on QO Furfural and its Derivatives.

Nitration of furfural and subsequent treatment with semicarbazone yields nitrofurfural semicarbazone, which is finding use in the pharmaceutical field as a bactericide in human therapy and in the veterinary field for treatment of coccidiosis in chickens, and enteritis in swine.

There are many other possibilities for product development using furfural as a starting material. Furfural is particularly attractive as a raw material in organic synthesis.



ORGANIC SYNTHESIS

QO furfural possesses properties common to aldehydes and in addition exhibits several unique characteristics because of its 5-membered heterocyclic furan ring. Catalytic decarbonylation of furfural yields furan which may be hydrogenated to tetrahydrofuran. Tetrahydrofuran undergoes ring opening to form 1,4-disubstituted butane. Such difunctional open chain compounds are useful in producing nylon and other linear polymers.

QO furfural is derived from agricultural residues rather than from the food or fiber portions of farm products. This makes for price stability and excellent availability.

The Quaker Oats Company
CHEMICALS DEPARTMENT

335Y, The Merchandise Mart, **Chicago 54, Illinois**
Room 535Y, 120 Wall Street, **New York 5, New York**
Room 435Y, 48 S. E. Hawthorne Blvd., **Portland 14, Ore.**
In the United Kingdom: Imperial Chemical Industries, Ltd., Billingham, England
In Europe: Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota", Copenhagen, S. Denmark
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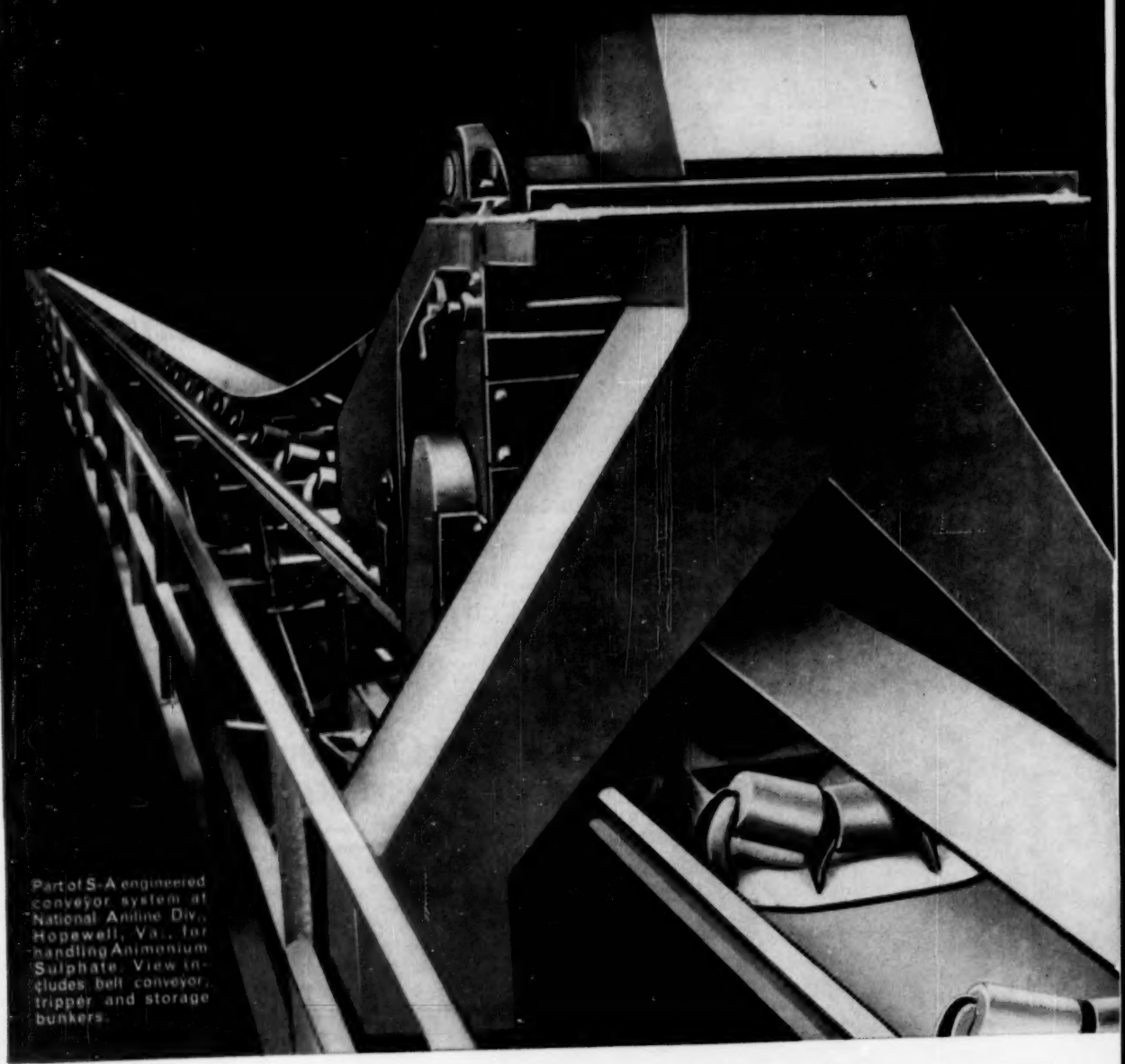
STEPHENS-



Part of S-A engineered conveyor system at National Aniline Div., Hopewell, Va., for handling Ammonium Sulphate. View includes belt conveyor, tripper and storage bunkers.

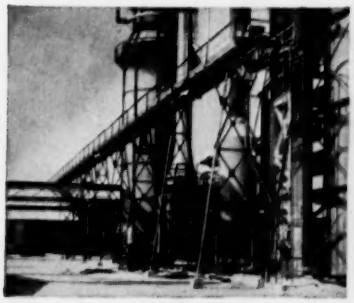
-ADAMSON

thru better bulk material conveyor systems

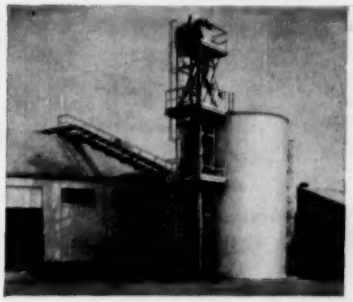
One of the basic aims of the chemical industry is improvement of processing. For many years, STEPHENS-ADAMSON has aligned its efforts with this aim by providing better, more scientific methods of bulk material movement in the processing plant.

The industry continues to grow at an amazing pace. STEPHENS-ADAMSON has watched this growth for over fifty years, matching it, stride for stride, with progressive development of a tremendously broad line of conveyor products designed to handle any dry bulk material. Superior engineering techniques of applying these products have played a great part in reducing chemical plant production costs.

Flexible mechanization of your material handling methods is essential if you are to provide for expansion and, at the same time, move your products at the lowest cost per ton.



250-foot long Zipper belt conveyor moves catalyst for Continental Oil Co., Lake Charles, La. The system was engineered on the horizontal to insure minimum material degradation. Power is supplied thru a SACO speed reducer. Conveyor capacity is 10 T.P.H.



The Butay Products Co., Los Angeles, Calif., uses a batch skip and REDLER conveying and elevating system for handling Sodium Sesquicarbonate. Sealed casing construction of the REDLER conveyor eliminates all dusting, protects product inside and out.

Sulphur is loaded to ships with an S-A conveyor system by the Mexican Gulf Sulphur Co., Veracruz, Mexico. The system includes belt conveyors, hopper, crusher, loading tower, boom conveyor and chute. Ample provision for expansion has been made.

S-A

STEPHENS-ADAMSON MFG. CO.

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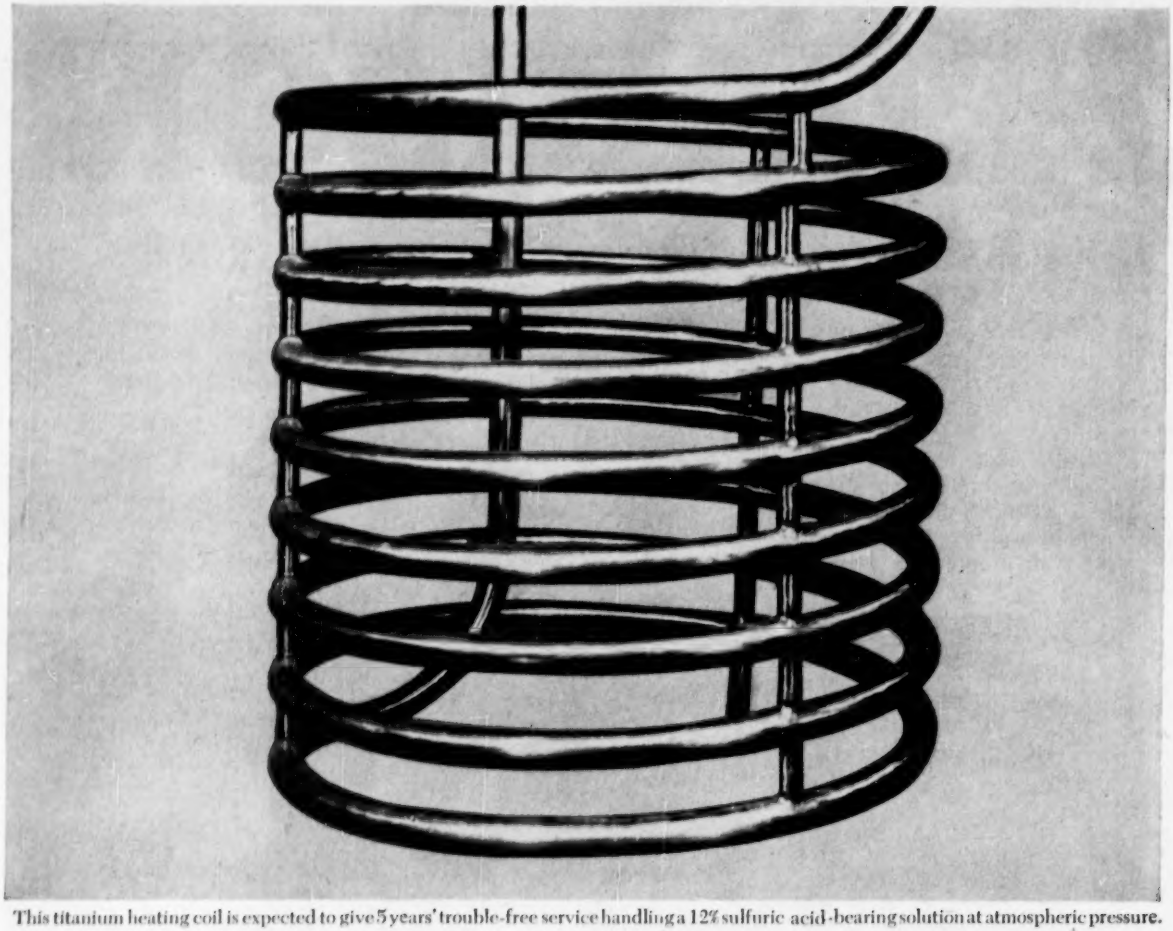
S-A manufactures a wide range of material handling products in three complete plants in U. S. and Canada.

- Belt Conveyors
- Belt, Pan & Plate Feeders
- Ship Loading Boom Conveyors
- Stacking Conveyors
- Storage & Reclaiming Systems
- "Natural Frequency" Vibrating Conveyors
- REDLER Conveyor-Elevators
- ZIPPER Conveyor-Elevators
- Conveyor Belt Cleaners
- Headshaft Holdbacks
- Grizzlies & Screens
- Centrifugal Pilers
- Bin Gates & Tunnel Gates
- Car Pullers & Spotters
- Bucket Elevators
- Skip Hoists
- SEALMASTER Ball Bearing Units

• *Write for a bulletin on any of the above products*

TITANIUM—available now for long service



This titanium heating coil is expected to give 5 years' trouble-free service handling a 12% sulfuric acid-bearing solution at atmospheric pressure.

Titanium coil heats sulfuric acid solution in presence of metallic sulfates

• LASTS 66% LONGER THAN SILVER
• CUTS OPERATING COSTS* BY 35%

Stress corrosion cracking limited the service life of a silver heating coil to 3 years. Maintenance was frequent and costly. The environment, a 12% sulfuric acid-bearing solution containing metallic sulfates, proved to be one in which titanium excelled. A titanium coil was installed... investigation after 9 months showed no pitting or cracking. Based on this performance, the estimated service life of this coil is 5 years, or 66% longer... with savings of 35% in operating costs.

**Includes repair labor, replacement materials and depreciation.*

life . . . corrosion resistance . . . economy in use

Proven economies

Titanium is actually the *least expensive* metal you can use under many corrosive influences. It withstands conditions that reduce the service life of ordinary and high-alloy metals . . . cuts downtime and replacements.

Titanium offers the economy of long, trouble-free service when exposed to such corrosive environments as:

Salt Water
Marine Atmospheres
Nitric Acid
Wet Chlorine
Chlorinated Organic Compounds
Most Inorganic Chloride Solutions
Molten Sulfur
Chromic Acid
Aqua Regia
Hypochlorites & Chlorine Dioxide

TITANIUM—available today

Titanium is now readily available for non-defense applications. Standard parts of titanium are already solving severe corrosion problems in the chemical, food, pulp, paper and allied industries.

In your process development work, take advantage of the corrosion and cavitation resistance, light weight and high strength of titanium . . . important considerations for continuous flow, high temperature and pressure processes.

As a manufacturer and pioneer producer of titanium sponge, Du Pont has been working with leading mill-products producers and process-equipment manufacturers on the commercial development of titanium. This broad experience can be applied to *your* corrosion problems. Just get in touch with Du Pont for further information.

Be sure to mail the coupon below for an informative booklet about titanium—its properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Titanium Market Development Section, Wilmington 98, Delaware. (This offer is limited to the United States and Canada.)

PIGMENTS DEPARTMENT

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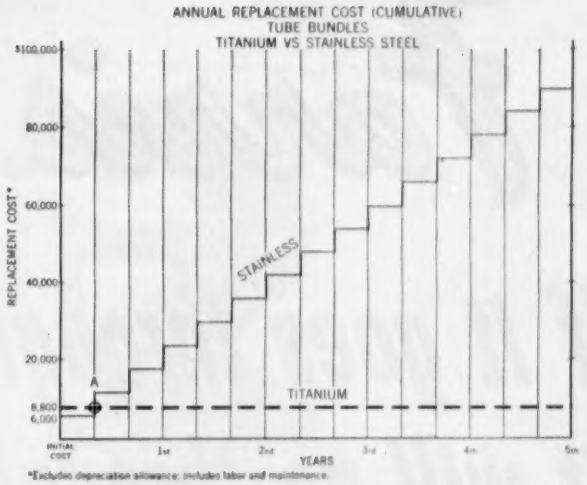
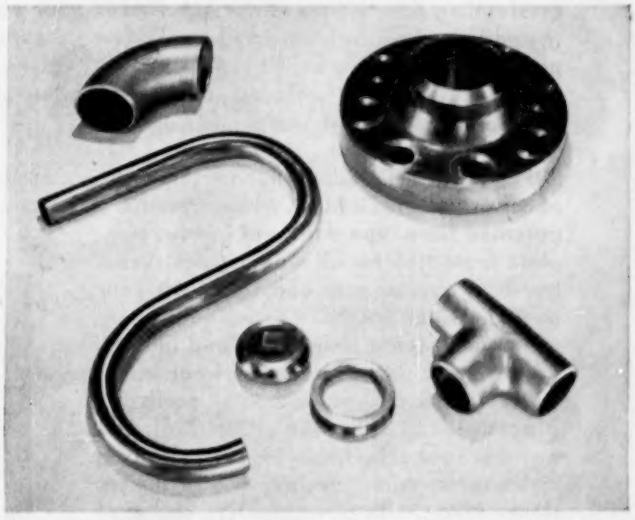
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



ANOTHER INSTANCE of titanium's long life is shown by this cost/service graph comparing titanium vs. stainless condenser tubes handling 60% nitric acid. Titanium tube bundle costs $8,800 vs. $6,000 for same unit in stainless. The $2,800 difference is absorbed within 4 months of service. Based on service life of 10 years, titanium will save at least $162,000 maintenance and replacement costs.



NOW AVAILABLE. Titanium parts and fittings like this tee joint, 90° weld ell, welding neck flange, pipe bend and powder metallurgy valve trim are just a few examples of standard commercial items now made of titanium.

Pioneer producer of TITANIUM SPONGE

Please send me more information on titanium. I am interested in evaluating titanium for these applications:

_____

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E. I. du Pont de Nemours & Co. (Inc.)
Titanium N-2496, CE-2, Wilmington 98, Delaware

*Name*_____ *Title*_____

*Firm*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

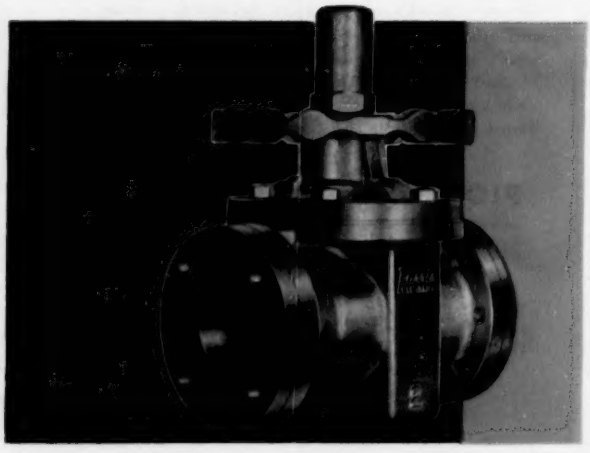
Farris

FLEX SUPERSEAL VALVE

If it goes through a pipe – it will go through a Flex Valve

The perfect valve for industry's toughest service! The Farris SUPERSEAL combines all the outstanding advantages of the standard 26-year job-proven flexible valve plus the added safety and performance of a complete metal enclosure...sealing in all movable parts and the flexible body itself. SUPERSEAL valves are ideal for full-pipe-capacity service under higher pressures, carrying a variety of materials from corrosive acids and chemicals to wet cement and wood chips!

SUPER SAFETY! Pressure tight housing fully encloses the flexible body, preventing escape of corrosive or toxic fluids when excessive wear takes place on the flexible body; patented flare-type dual seal insures complete protection for all working parts; cast housings available in alloys to meet your needs...SUPER ECONOMY! Self-supporting for money-saving installation and maintenance; inner valve bodies outwear metal 11 to 1; low cost valve bodies easily replaceable...SUPER SERVICE! Minimum hand-wheel effort; novel, self-aligning chain drive; minimum face-to-face dimensions; wide choice of accessories; choice of models for all requirements.

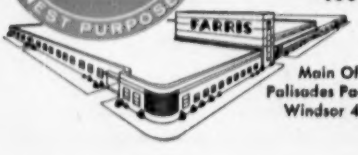


Series 5200
Manually Operated SuperSeal operates with minimum effort

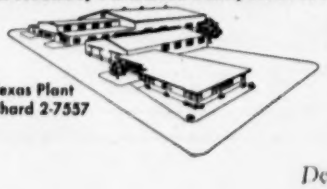
PROGRESS THROUGH HONEST PURPOSE

Farris **FLEXIBLE VALVE CORP.**

400 Commercial Avenue, Palisades Park, N. J. In Texas: 5405 Clinton Drive, Houston 20



Main Office
Palisades Park, N. J.
Windsor 4-6300



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FARRIS HYDROTORQUE CORPORATION
FARRIS HYDROSEAL CORPORATION

1 **Superview Indicator and Stop**

2 **Non-Rising Hand Wheel—Minimum Effort**

3 **Durable Acme Thread—Stainless Stem**

4 **Completely Enclosed Metal Housing—Self Supporting**

5 **Patented Flare Type Dual Seal**

6 **Longer Life—Low Cost Body of Standard Fabric or High Strength Nylon**

7 **Self-Aligning Chain Drive**

Series 5300 and 5400

Diaphragm Motor-Operated Superseal with valve positioner for automatic remote operation.

FARRIS FLEXIBLE VALVE CORP.
801 Commercial Avenue, Palisades Park, N. J.

Gentlemen: Tell me more about the Farris SUPERSEAL Flex Valve.

☐ Mail Catalog Information. ☐ Have your representative call on me.

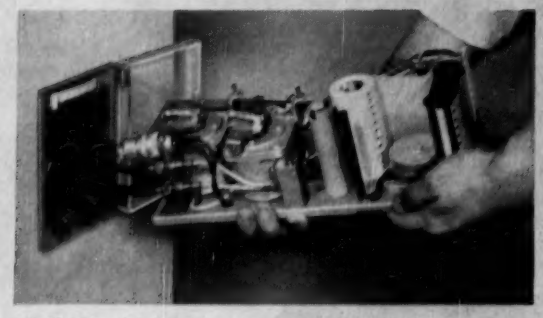
NAME_____ TITLE_____

COMPANY_____

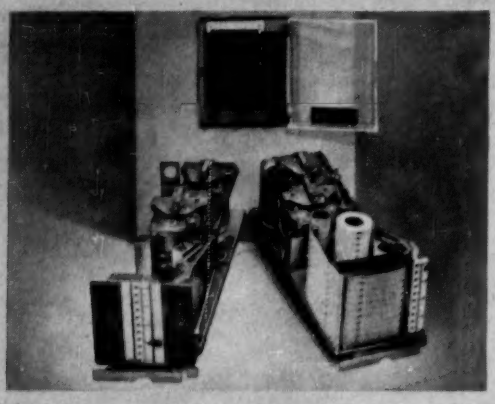
ADDRESS_____

CITY_____ STATE_____

CLIP THIS COUPON TO YOUR LETTERHEAD AND MAIL TODAY

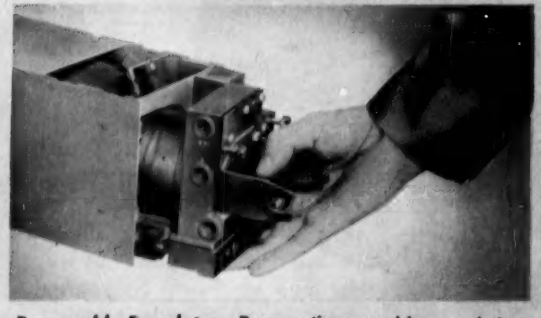


Easily Serviced—All parts can be inspected during operation, without process interruption. To remove chassis completely, unscrew three finger-tight, self-sealing connections.

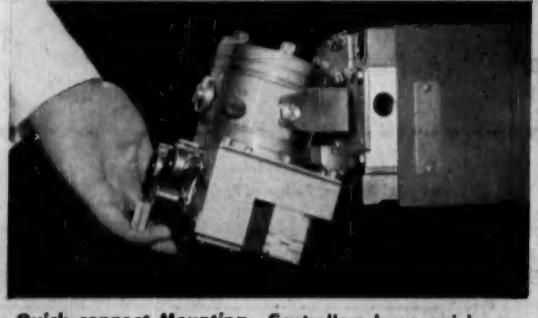


Interchangeable Chassis—Change recorder to indicator or vice versa without interrupting control. Simply pull out chassis, slide another in place.

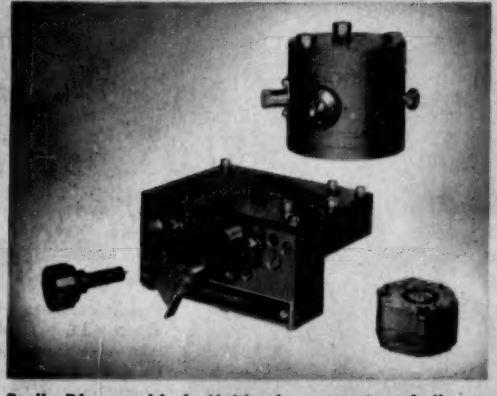
Now you can gain ... *Extra*



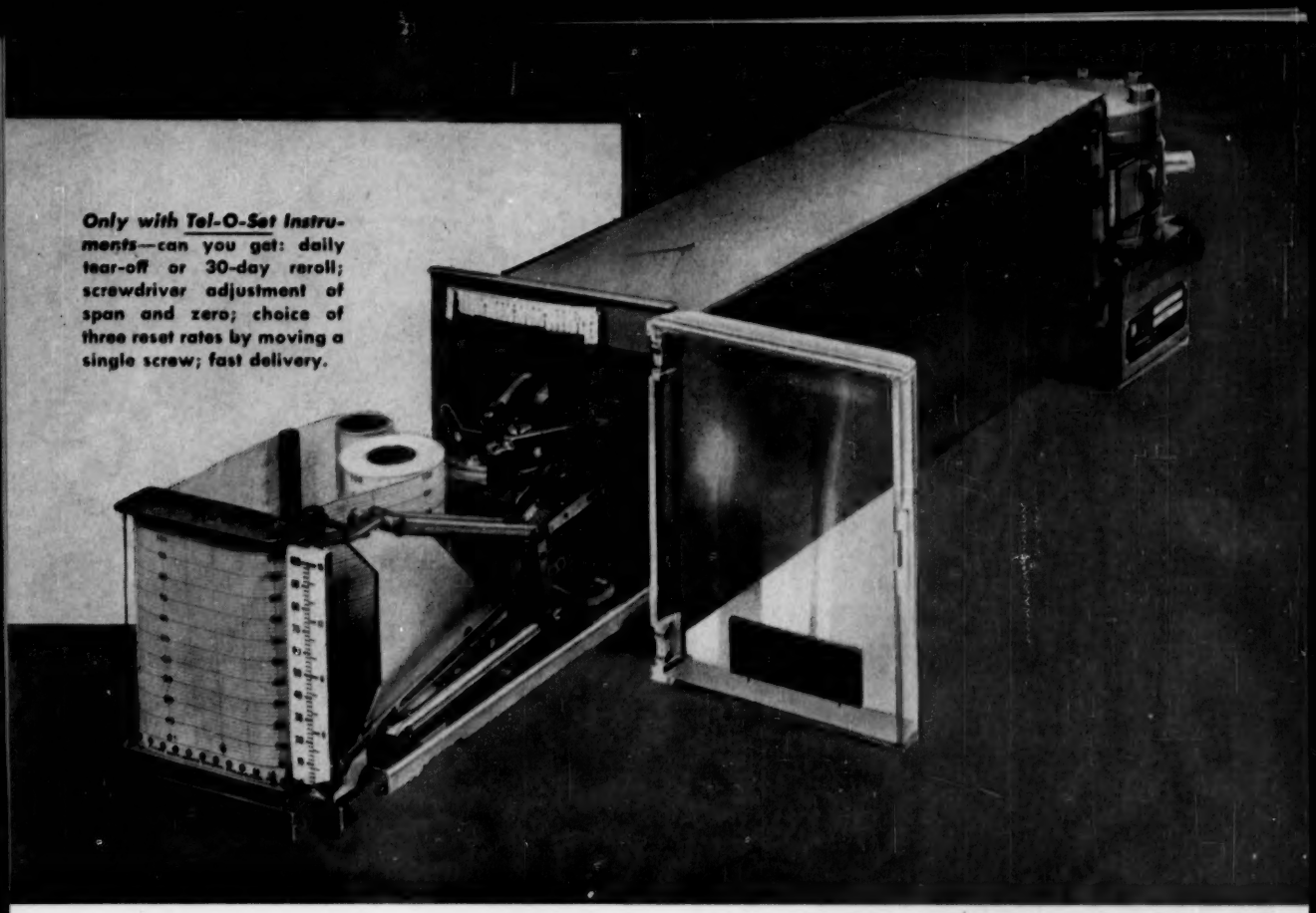
Removable Regulator—Pneumatic assembly, consisting of regulator and switches, can be removed from rear of case without disturbing electrical connections—no need for an electrician to stand by.



Quick-connect Mounting—Controllers have quick-connect switch permitting removal of the unit while process remains on manual control.



Easily Disassembled—Unitized construction of all controller components simplifies maintenance . . . makes reassembly foolproof. No need to dismantle stack to clean pilot assembly.


Only with Tel-O-Set Instruments—can you get: daily tear-off or 30-day reroll; screwdriver adjustment of span and zero; choice of three reset rates by moving a single screw; fast delivery.

Savings with TEL-O-SET*

. . . advanced miniature pneumatic instruments

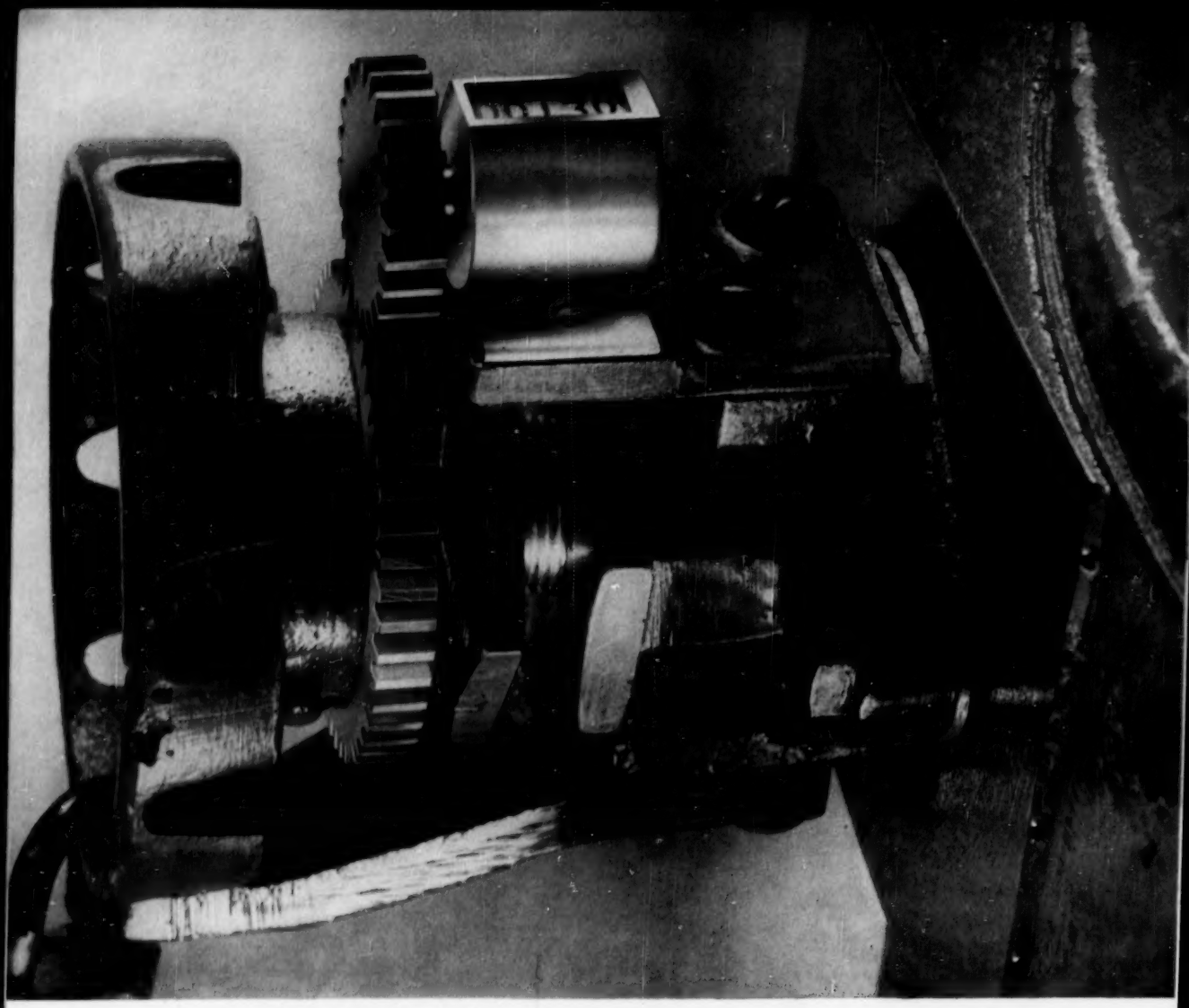
Tel-O-Set miniature instruments accurately record, indicate, and control process variables. They're applicable to any process variable . . . a savings in itself. And, further savings are accrued from these factors: Only a few models are needed for *all* applications . . . Personnel training time is minimized . . . Spare parts inventory is reduced . . . Process techniques can be changed without buying new instruments. The photographs point up some of the outstanding *Tel-O-Set* features.

For complete information on *Tel-O-Set* instruments, write for Catalog C 1001-1, or call your nearby Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—

*Trade name Minneapolis-Honeywell Regulator Co.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls



Air-Gas Ratio Valve

For precise control of inert gas quality . . .

Come to Kemp

Heyden Chemical saves over $500 a month with CO_2 supplied by this Kemp Inert Gas Generator. Kemp units are on the job in leading plants everywhere, cutting costs and providing greater safety.

Only Kemp Inert Gas Generators have the famous Kemp Industrial Carburetor at the vital heart of the process. This carburetor, developed and patented by Kemp, gives exacting control to the generation of inert gasses. From mere pilot burner operation to full generator capacity, inert gas analysis is exact and constant, regardless of demands on the system.

Kemp-produced inerts are low-cost inerts. You can use them liberally, at a fraction of the cost of bottled gasses, for purging, blanketing, controlling reactions, agitation, or any of a hundred applications. You get better quality control and increased safety at the lowest possible operational cost.

For round-the-clock inert production with minimum maintenance, depend on Kemp Inert Gas Generators. Your Kemp Representative will suggest the proper model to fill your needs. Or write us direct for Bulletin I-10. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

Kemp Convection Dryers

Kemp Immersion Melting Pots

KEMP OF BALTIMORE

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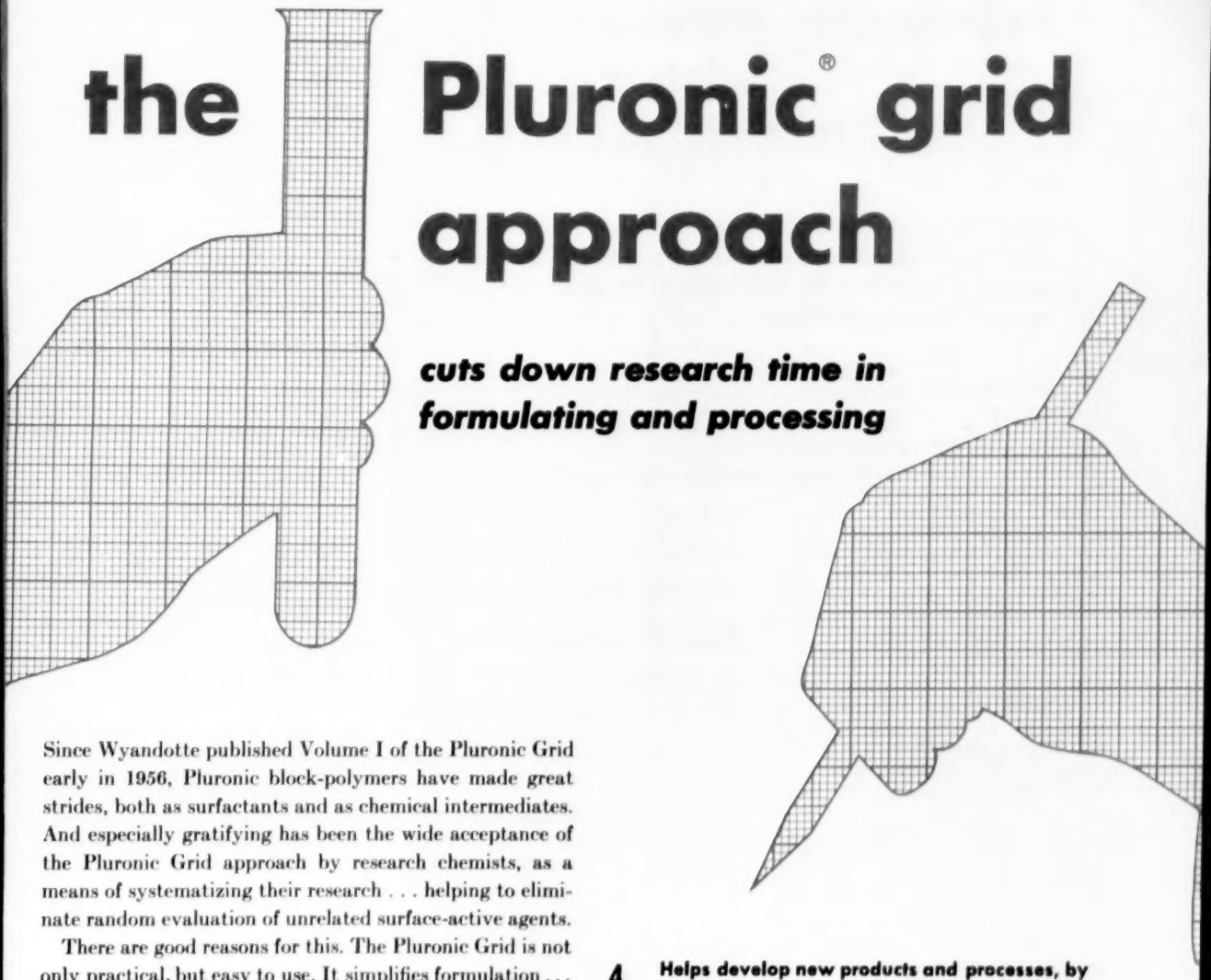
Kemp Orlad Dryers

the Pluronic® grid approach

cuts down research time in formulating and processing



Since Wyandotte published Volume I of the Pluronic Grid early in 1956, Pluronic block-polymers have made great strides, both as surfactants and as chemical intermediates. And especially gratifying has been the wide acceptance of the Pluronic Grid approach by research chemists, as a means of systematizing their research . . . helping to eliminate random evaluation of unrelated surface-active agents.

There are good reasons for this. The Pluronic Grid is not only practical, but easy to use. It simplifies formulation . . . suggests in advance the characteristics you can get using a Pluronic or a combination of Pluronics. More and more laboratories are finding that, by first using the Pluronic Grid approach, they can determine *with just one or two tests* whether or not the Pluronics are applicable. If they are, then a few additional tests will determine the Pluronic, or combination of Pluronics, with the best balance of properties to solve their problem.

In brief, the Pluronic Grid approach offers these advantages:

1. **Provides a controlled, systematic method of screening.**
2. **Minimizes costly random screening by establishing property trends.**
3. **Offers a simple method of determining the effects of changes in molecular weight and in hydrophobic-hydrophilic ratio.**
4. **Helps develop new products and processes, by the accumulation of information on related grades of Pluronics that would have been impossible with random screening of other surface-active agents.**
5. **Permits the chemist to find the Pluronic, or combination of Pluronics, with the best balance of properties for the solution of his problem, instead of trying to formulate to a surfactant's properties.**

When the Pluronic Grid was first conceived, it contained only six members. The number has since been increased to 21. Most of the additions were at the request of major laboratories . . . to help improve the Grid approach. These chemists found that a greater number of grades, with smaller incremental changes, permitted them to obtain a more exact balance of properties with less actual laboratory work. Special grades are constantly being evaluated in highly diversified fields. These new developments make it advantageous for you to keep abreast of the progress in Pluronics' development.

Systematic selection with the Pluronic Grid

Using the Grid, you can select the Pluronic with the exact hydrophobic-hydrophilic ratio and molecular weight to give you the best balance of properties to satisfy your use conditions.

Why the Pluronic series is different

Chemists know that polyoxy*ethylene* compounds are water soluble—no matter how high their molecular weight. For many years, it was generally assumed that polyoxy*propylene* compounds would also be water soluble. However, the fact is: at a molecular weight of about 800-900, polyoxypropylene glycols become essentially water insoluble.

Investigation at Wyandotte revealed that if water-soluble polyoxyethylene groups were added to both ends of the water-insoluble polyoxypropylene chain, a complete series of new block-polymers with highly desirable surface-active properties would develop.

These block-polymers are prepared by adding propylene oxide to the two hydroxyl groups of a propylene glycol nucleus. The resulting hydrophobic base can be made to any controlled length, varying from 800 to many thousands in molecular weight.

By adding ethylene oxide to both ends of this hydrophobic base, it is possible to put polyoxyethylene hydrophilic groups on the ends of the molecule. These hydrophilic groups are controlled in length to constitute anywhere from 10% to 90% of the final molecule. The simplified structure can be represented as:

$$HO\,(CH_2\text{-}CH_2\text{-}O)_a\,\underset{\displaystyle CH_3}{(CH\text{-}CH_2\text{-}O)_b}\,(CH_2\text{-}CH_2\text{-}O)_c\,H$$

Other products on the market can usually vary only the hydrophile. The Pluronics are unique in that the size of *both* the hydrophobe and the hydrophile are variable, offering an additional dimension of freedom. This produces a wider range of properties, which vary in smaller, more controllable increments.

The Pluronics are the only block-polymer surfactants commercially available. They range in physical form from mobile liquids to solids sufficiently hard to be flaked. They are 100% active in all forms, and exhibit a wide variety of surface-active properties. They range in molecular weight from 1000 to over 11,000. They vary from materials that are almost water insoluble to materials that have no cloud point—even at the boiling point of water.

What is the Pluronic Grid?

The Pluronic Grid is a graphic presentation of this broad series, formed by plotting molecular-weight ranges of the hydrophobe against the percent of the hydrophile in the final molecule.

Pluronic nomenclature

To simplify the naming of the Pluronics, they are identified by a letter (L, P, or F) and a two-digit number. The letter identifies the physical form of the particular Pluronic: L for liquid, P for paste, F for flake. The first digit identifies the typical molecular weight of the hydrophobic base, as indicated by the column to the left of the Grid. The second digit suggests the approximate percent of ethylene oxide in the total molecule.

Thus, Pluronic F68 is a flake with a hydrophobic-base molecular weight of approximately 1750; 80% of the molecule, by weight, consists of hydrophilic polyoxyethylene groups, and the remaining 20% is hydrophobic polyoxypropylene groups.

Total molecular weights of the Pluronic grades can be easily computed. For example:

$$\text{Molecular weight of F68} = \frac{1750}{.20} = 8750$$

1750 is the typical molecular weight of the polyoxypropylene base for those Pluronic grades whose first digit is 6. And .20 means that 20% of the molecule, by weight, is polyoxypropylene.

How to use the Pluronic Grid

Because of the wide range of molecular weight obtainable in the Pluronic series—and because of the two degrees of freedom (controlling the molecular weights of both the hydrophobe and the hydrophile)—properties of the Pluronic grades can be plotted as trends across the Grid.

By observing these trends, the formulator can select—from the Grid—those Pluronic grades having the best balance of properties for his particular application. After only a few laboratory tests, he can narrow this area down to the best Pluronic or combination of Pluronics for his formulation.

Known trends for several general properties of the Pluronic series are shown; other specific trends can be determined easily by evaluating a few Pluronic grades from various positions on the Grid. In this way, it is possible for anyone to plot their own trends . . . individual trends directly pertaining to their own operations, conditions, or problems.

Example I:

Formulating a machine-dishwashing compound

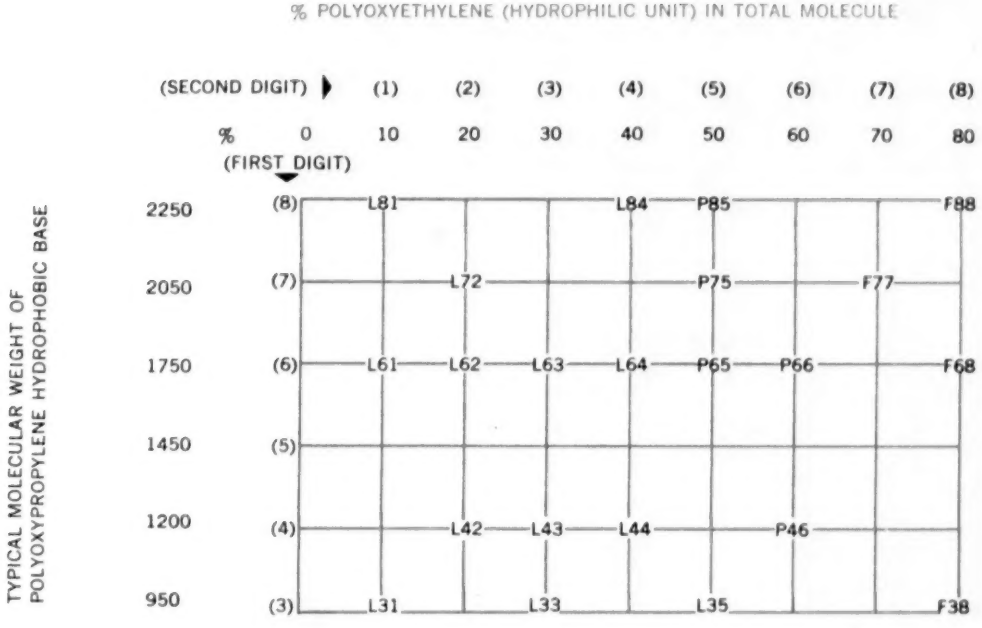
The surface-active agent used in a machine-dishwashing compound should have the following properties: good rinsing; very low foam; good wetting; good detergency; good lime-soap-dispersing ability; good dedusting properties; extremely low toxicity.

Rather than initiate a random evaluation of all the unrelated surface-active agents now commercially available, the formulator can save research time—and direct his efforts in an organized approach to the problem of selecting a suitable surfactant—by referring to the Pluronic Grid.

Very low foam is extremely important in a machine-dishwashing compound. And it can be seen that the lowest foaming Pluronic polymers are in the lower left quadrant of the Grid. The property trends also indicate that the best wetting and penetrating action is in the lower left quadrant . . . this area also has excellent rinsing.

The area of best detergency is in the central portion of the Grid. The best lime-soap-dispersing properties are found in the upper right quadrant. The cloud point and solubility of the Pluronics increase in moving toward the right side of the Grid . . . the formulator may choose a Pluronic having any degree of solubility desired. (*Continued on back page.*)

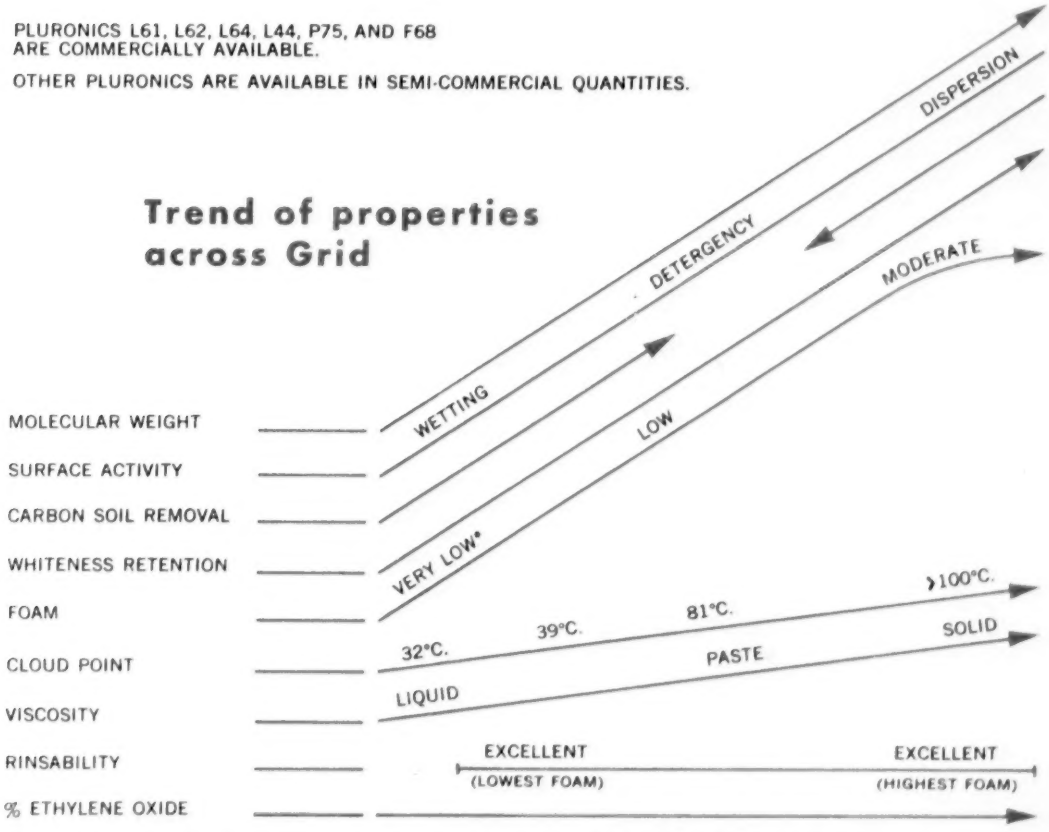
Pluronic Grid


% POLYOXYETHYLENE (HYDROPHILIC UNIT) IN TOTAL MOLECULE
(SECOND DIGIT) ▶ (1) (2) (3) (4) (5) (6) (7) (8)
% 0 10 20 30 40 50 60 70 80
(FIRST DIGIT)
TYPICAL MOLECULAR WEIGHT OF POLYOXYPROPYLENE HYDROPHOBIC BASE
2250 (8) L81 L84 P85 F88
2050 (7) L72 P75 F77
1750 (6) L61 L62 L63 L64 P65 P66 F68
1450 (5)
1200 (4) L42 L43 L44 P46
950 (3) L31 L33 L35 F38

PLURONICS L61, L62, L64, L44, P75, AND F68 ARE COMMERCIALLY AVAILABLE.

OTHER PLURONICS ARE AVAILABLE IN SEMI-COMMERCIAL QUANTITIES.

Trend of properties across Grid



EMULSIFICATION— ALL PLURONICS HAVE FOUND APPLICATIONS AS EMULSIFYING AGENTS.

*ABOUT 10% PLURONIC L61 (BASED ON THE TOTAL WEIGHT OF PLURONIC) EFFECTIVELY REDUCES THE FOAMING OF THE OTHER PLURONICS.

Since rinsing, foaming, and wetting are the most important properties, the formulator should evaluate Pluronic grades L62, L63, L42, and L43 in his particular formulation.* This systematic approach to the problem can eliminate much fruitless work in unprofitable areas.

The same principles have been applied to developing a suitable rinse aid in mechanical dishwashing, where a small amount of surfactant is injected into the last rinse to improve and minimize water spotting and streaking — particularly on glasses, silverware, and plastics. In this application, very low foam, good rinsing, good wetting action, and low toxicity are of primary importance, and this again suggests the area of L62, L63, L42, and L43.

An added advantage of all the Pluronics, not indicated by the Grid, is their extremely low toxicity . . . and liquid grades give permanent dedusting.

** It should be noted that L61, L31, and L81 were not considered in this application because of their very low cloud point. However, added in small quantities to any of the other Pluronic grades, they will effectively suppress foam. Field tests have shown that a 1:9 ratio of L61 to L62 or L63 (or any other Pluronic on the Grid) effectively lowers their foam without adversely affecting their other characteristics.*

Example II:

Formulating a dispersing agent for hydrophobic pigments

In wetting and dispersing hydrophobic pigments in water, at relatively high solids content, any agent added to aid in dispersion should have the following properties: good dispersing; good wetting; relatively low foam; chemical stability; light color; and the ability to create a hydrophilic surface.

Good dispersion and the most hydrophilic characteristics are found in the upper right quadrant (or high-molecular-weight area) of the Grid. The best wetting and the lowest foam are in the lower left quadrant. Since dispersion and hydrophilic characteristics are the most important properties, and since the foam and the wetting action of the Pluronics in the upper right quadrant are not objectionable, F68 and F88 are the most logical to evaluate.

In actual tests, both of these proved to be very effective in preparing high-solids slurries in water, with F88 being the better of the two. However, when latex binder was added to these slurries, they tended to form gels after extended standing. Further tests revealed that the addition of L81 (the most hydrophobic Pluronic) to the F88 grade made these gels highly fluid again. Later investigation of the area between the two extreme ranges revealed that P85 produced a very satisfactory product that was completely stable at high solids content.

the Pluronic series has a growing list of commercial applications!

Agricultural Products: Emulsifiers; emulsion stabilizers; dispersing and wetting agents; dust-laying agents.

Cosmetics: Deodorants; hair preparations; lotions; oral-hygiene products; shampoos.

Formulated Detergents: Laundry products; dairy cleaners; detergent sanitizers; floor cleaners; rug cleaners; mechanical-dishwashing products; rinse aids; scouring powders.

Latex and Rubber: Stabilizers; viscosity regulator for styrene-butadiene latices; vulcanizers.

Metal Cleaning: Alkaline metal cleaners; aluminum anodizing; passivating; steel pickling.

Metal Cutting: Water-soluble coolant and lubricant formulations.

Paint: Emulsion paints; pigment dispersing; improved leveling, spreading, and brushability; viscosity control.

Paper: Coating colors, reducing viscosity; pigment dispersing; latex stabilizing.

Pharmaceuticals: Dispersants for antibiotics; solubilizers for antibiotics and vitamins.

Petroleum: Demulsifying agents; dispersants and lubricants for drilling muds; wetting agents for secondary recovery.

Plasticizers: Methylmethacrylate, phenol-formaldehyde, urea-formaldehyde, and polystyrene resins.

Polyurethane Resins: Reacting with diisocyanates to give economical foams of superior properties.

Soap: Soap-synthetic and all-synthetic bars; lime-soap dispersant.

Textiles: Desizing formulations; antistatic agents; continuous hypochlorite bleaching; dye leveling; kier boiling; soaping-off prints; softening warp sizes.

Water Treating: Boiler water; scale prevention in industrial water supplies.

The Pluronic Grid can help you choose the proper chemicals for testing, but only a thorough evaluation in your own laboratories can give you the full scope of what the Pluronic polyols can do for you. Write today for samples, data sheets pertinent to your application, and other technical information. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

Wyandotte CHEMICALS

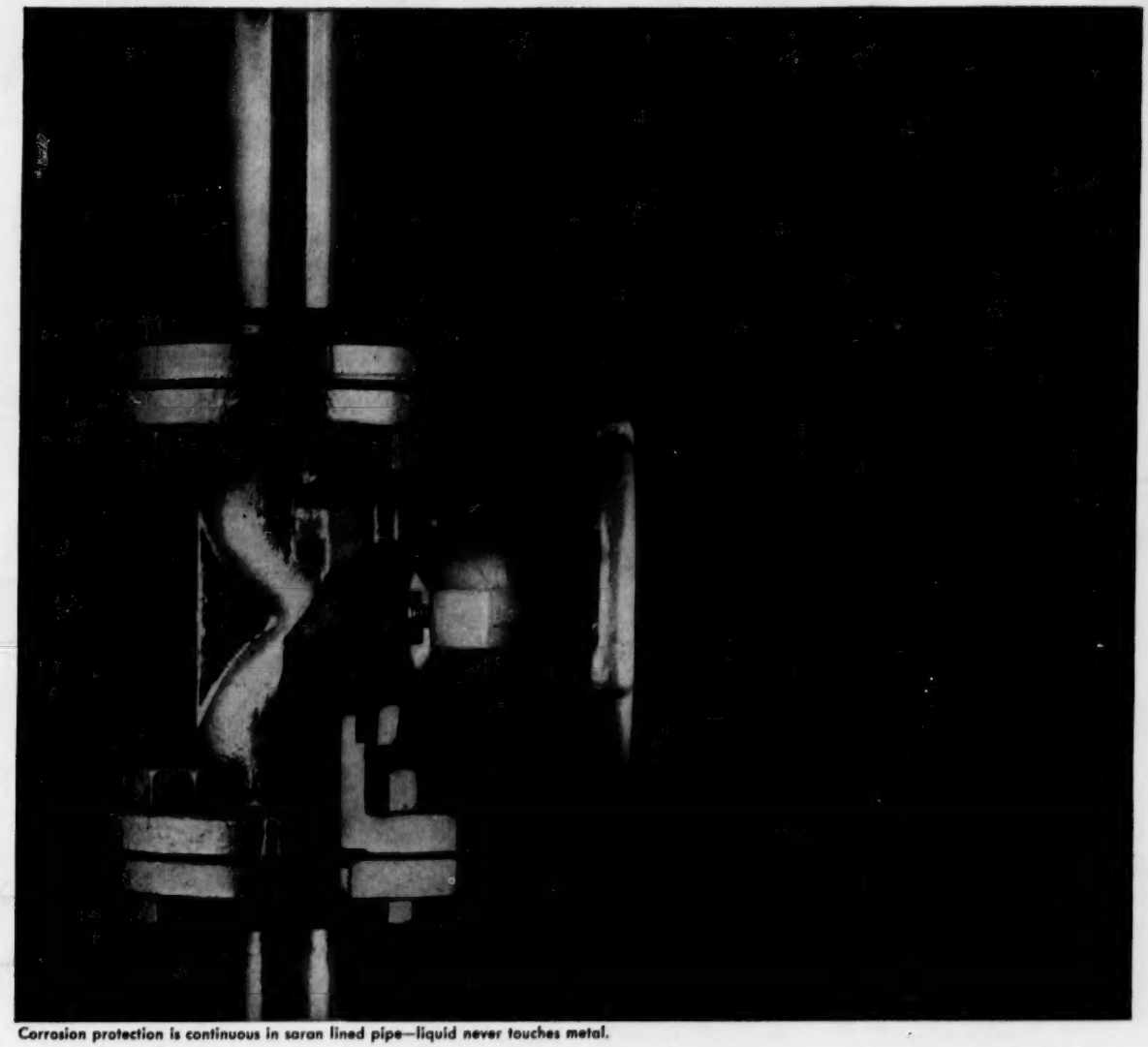
MICHIGAN ALKALI DIVISION

Pacing Progress with Creative Chemistry

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CHLORINE
MURIATIC ACID • CALCIUM CARBONATE • CALCIUM CHLORIDE
GLYCOLS • CHLORINATED SOLVENTS • SYNTHETIC DETERGENTS
OTHER ORGANIC AND INORGANIC CHEMICALS

Litho in U.S.A.

Form No. 563



Corrosion protection is continuous in saran lined pipe—liquid never touches metal.

You can see why Saran lined pipe prevents corrosion

Corrosive liquids never touch the rigid steel pipe . . . it's lined with durable saran

You can stop downtime and other corrosion-caused losses by using saran lined pipe.

The saran liner, over which is swaged a steel pipe, gives complete protection from commonly used acids, alkalies and many other corrosive liquids. At no time do these liquids touch the rigid steel pipe, its fittings or valves.

You'll like the labor-saving way it fabricates. Cutting and threading can be done in the field with conventional hand or power tools. And you can hang it in the same manner as ordinary steel pipe.

Saran lined pipe has high bursting strength, withstanding working pressures up to 300 psi. Fittings and valves are available in cast iron or malleable iron for 150 psi working pressures and in cast steel for 300 psi working pressures.

For tomorrow's protection today, investigate saran lined pipe. THE DOW CHEMICAL COMPANY, Midland, Michigan.

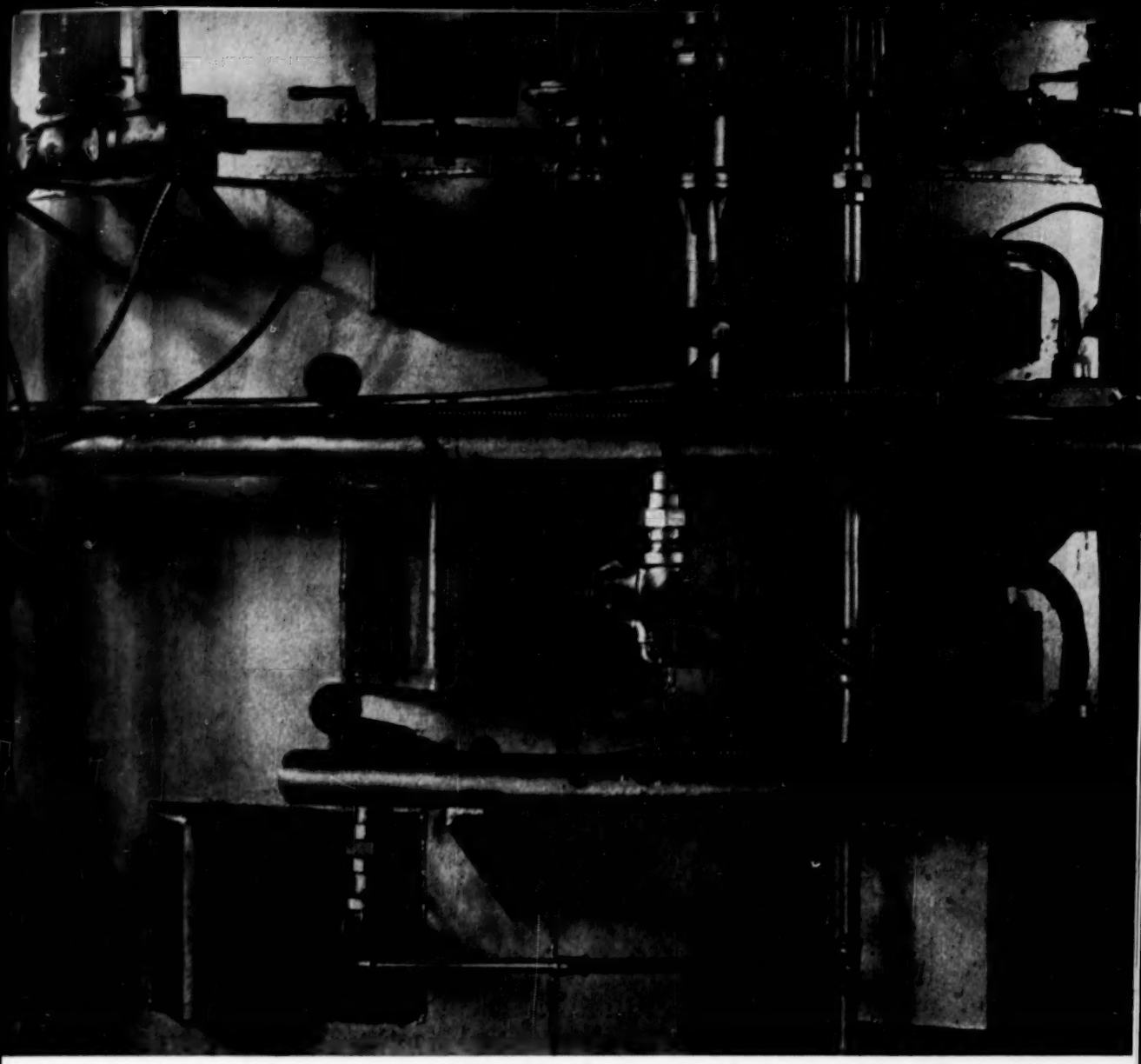
SARAN LINED PIPE COMPANY
DEPT. SP1593A-2
2415 BURDETTE AVENUE
FERNDALE 20, MICHIGAN

Please send me information on saran lined pipe, fittings and valves.

Name_____ Title_____ Company_____

Address_____ City_____ State_____

YOU CAN DEPEND ON DOW

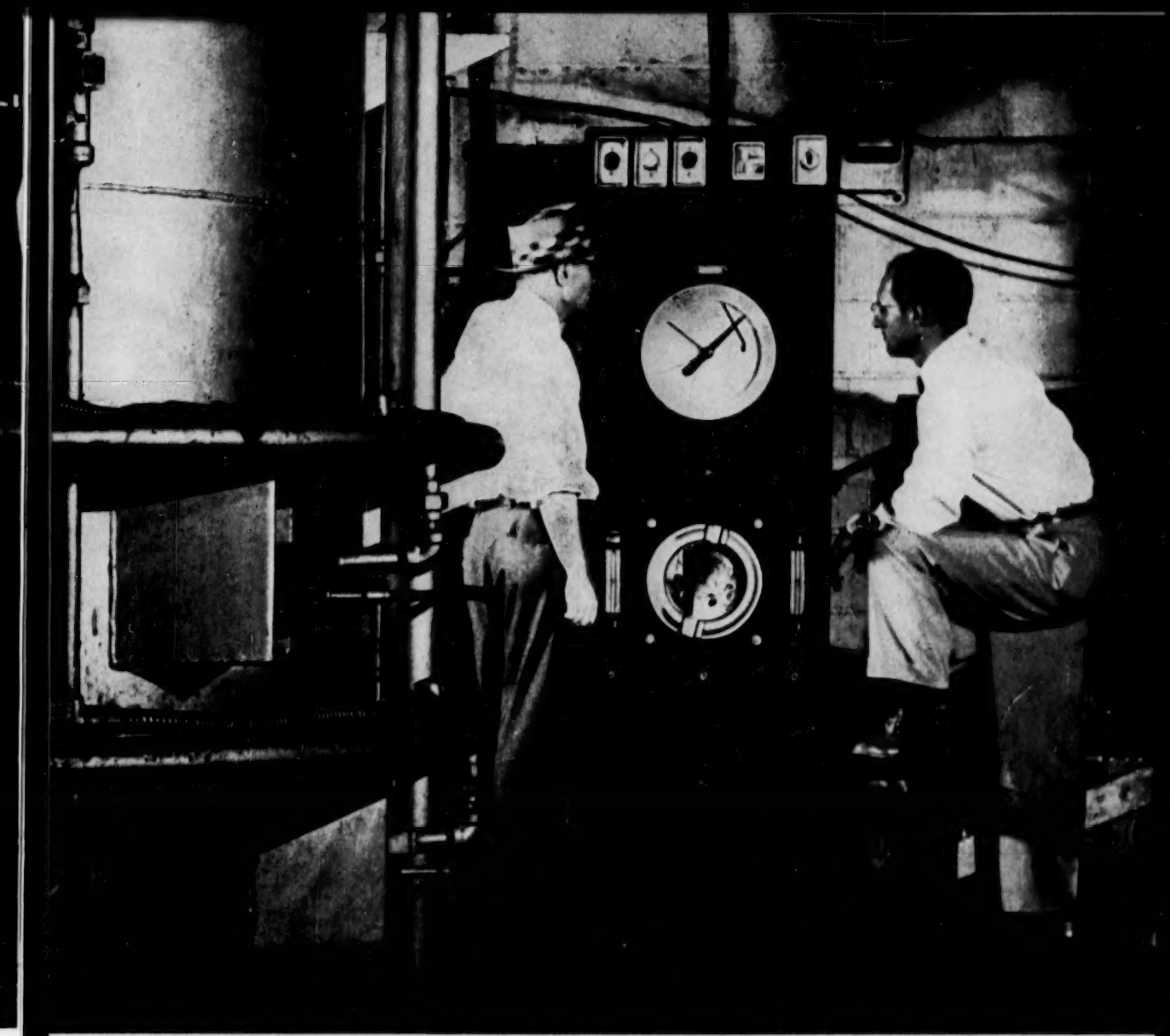


Engineering follow-up on M-S-A® assures dependable performance

The performance of an MSA gas analyzer—*after installation*—is a major concern of ours. That's why we place so much stress on engineering follow-up.

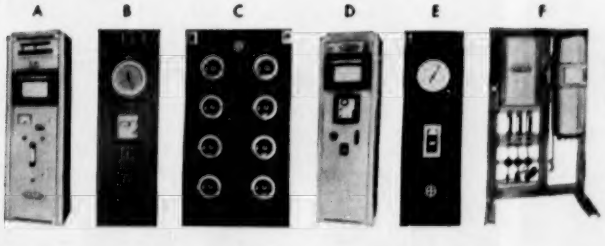
Briefly, here's what this service means to you. To make sure your analyzer is dependable, there's an MSA Instrument Specialist available to instruct plant personnel in the operation and maintenance of the new instrument. And while he doesn't get in on the piping or wiring connections, he'll be by to see that your gas analyzer is doing the job for which it was ordered.

This in-the-plant observation is just the beginning of the MSA man's continued interest in your satisfaction. He's on call to help you. So next time you have a process stream problem, talk to him first. For the name of the MSA man nearest you, or for specific information on any of our basic units, just write.



This MSA Field Service Engineer (right) is discussing gas analysis on a follow-up call with a plant superintendent. The M-S-A Inert Gas Analyzer which he's checking, is solving a number of complicated annealing furnace problems.

gas analyzers from the start

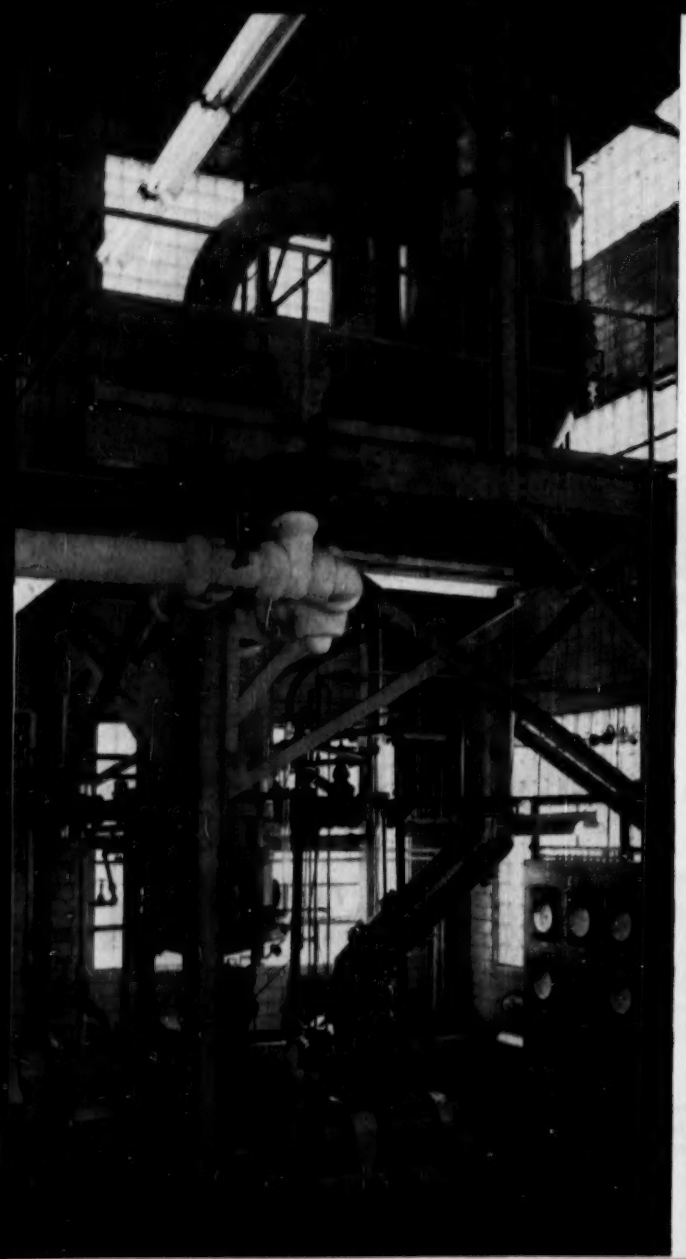


A. M-S-A (LIRA) Infrared Analyzer
B. M-S-A Inert Gas Analyzer
C. M-S-A Combustible Gas Analyzer
D. M-S-A Gas Thermatron
E. M-S-A Oxygen Indicator
F. M-S-A Water Vapor Recorder

INSTRUMENT DIVISION

MSA

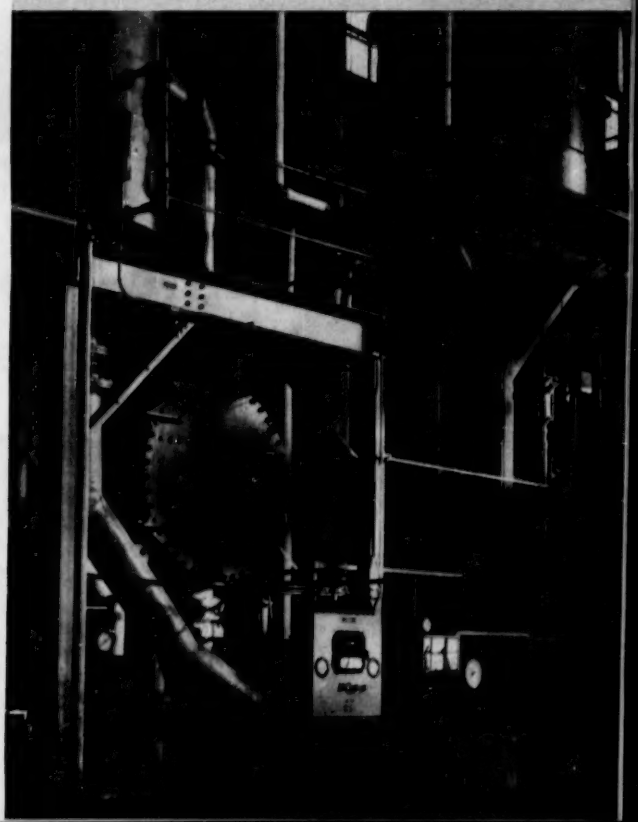
MINE SAFETY APPLIANCES COMPANY
Pittsburgh 8, Pennsylvania

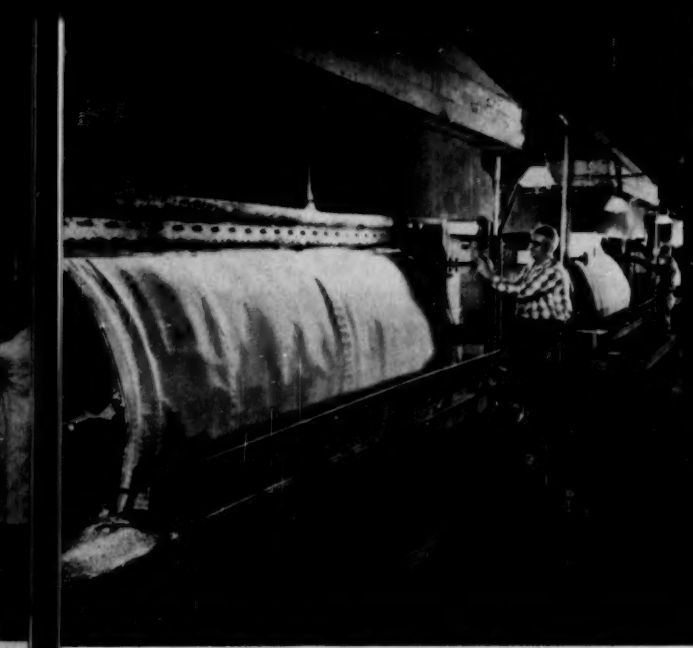


Twin Coach Aircraft Division controls this metal bonding autoclave entirely automatically. Quick Opening Doors speed operation.

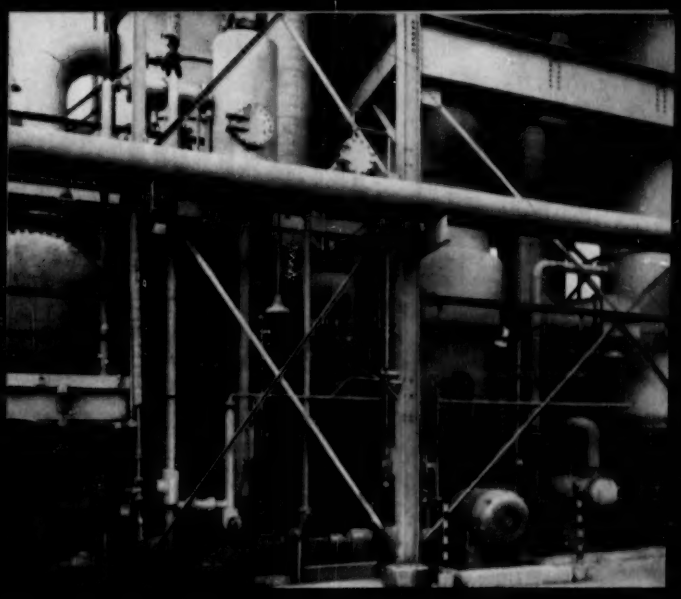
Hercules Powder uses an acid resistant, forced circulation evaporator to concentrate highly corrosive protein solution.

Fish Products utilizes two evaporators to recover vitamins and protein solids from fish oil waste.





National Distillers produces livestock and poultry feed from distillery grain residue by continuous drying with Buflovak double-drum dryers.



Shell Chemical gets dependable glycerine concentration using less power with combination forced and vertical concentration evaporators.

Buflovak engineering pays off for progressive processors

Buflovak research solves the toughest processing problems

Buflovak has the best equipped laboratory for analyzing problems in drying, evaporation, extraction, solvent recovery crystallization and food engineering. Products can be tested by the beakerful or run in carload lots on a full production schedule. Over 7,000 tests have proven for hundreds of companies that product research is the sure way to profits.

Skilled engineering provides the right equipment for the job

Because the line is complete, Buflovak engineers can impartially recommend the right equipment to meet specific job requirements . . . basing their selection on known specifications, or on the results of special research. Whenever custom units are needed, Buflovak has the design know-how and production facilities to follow through.

Industry's most modern units upgrade products, improve operations

Dryers, evaporators, flakers, autoclaves, kettles . . . all the units in Buflovak line incorporate advanced design features developed by extensive product research. On schedule delivery . . . superior performance . . . low operating costs . . . and capable, available service are all part of the Buflovak program to build customer profit.

Send for Catalog 380:
"Buflovak Processing Equipment"

BLAW-KNOX

BLAW-KNOX COMPANY
Buflovak Equipment Division
1551 Fillmore Avenue, Buffalo 11, N.Y.

Giant Molecules for the Giant

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

Consumer Market

High polymer chemistry opens the door to new processes for the creation of new products to satisfy the hunger of the giant consumer market.

Republic is vitally interested in this exciting new field of science. As an integrated steel maker we are also a leading producer of high quality coal chemicals. From the recuperative process of transforming coal to coke for our blast furnaces come many of the basic chemicals used in making giant molecules.

Republic Benzols, Toluols, Tar, Pyridine, Crude Naphthalene, Xyols and Crude-Heavy Solvent are currently being used in the manufacture of hundreds of thousands of products. Ammonium Sulphate in mixed and blended fertilizers forms an industry in itself. Yet the surface has only been scratched. Of the nearly 2000 chemicals available from coal, only a small percentage have found their way into commercial use.

Concurrent with the work of polymer chemists in developing processes to speed the creation of new products and reduce the cost of present ones, Republic's own chemists are actively engaged in a program of coal chemical research. This program will enable Republic to keep pace in the rapidly growing field of giant molecules and to continue as a dependable source of supply for high quality, high purity coal chemicals.

Which of the Republic Coal Chemicals described at right can you use in your product or process to satisfy the giant consumer market?

Visit Republic's Booth, No. 60, at the 26th Exposition of Chemical Industries, New York Coliseum, December 2-6

THE GIANT CONSUMER MARKET reveals countless applications of Republic Coal Chemicals. Benzol is used in dyes for coloring cloth and fabric, in many types of wearing apparel, like nylon stockings, in synthetics for super-tough suitcases. It is also used in soaps and detergents. Perfumes are derived from Toluols. Pharmaceuticals are made from Pyridine. Xylols are basic in making riboflavin. Crude Heavy Solvents are used in waterproofing compounds and for stiffening leather.

COAL CHEMICALS IN THE HOME add convenience, comfort and pleasure. Refining of Tar permits its use in paints, roofing and insulating materials. Naphthalene is familiar in the form of moth balls, but it is also important in making synthetic enamels that keep products new looking longer. Benzol is used in making plastics for housewares, floor tiles, shower curtains, synthetic-rubber bath mats . . . also in the manufacture of aspirin and antiseptics.

COAL CHEMICALS ON THE FARM. Strong, healthy cattle reach marketable size faster. Xylols produced by Republic are used in the manufacture of germicides to protect livestock from germs and microorganisms. Ruined and farmed-out land is restored with the help of Ammonium Sulphate in mixed and blended fertilizers. Benzol is a basic material in the production of agricultural chemicals designed to control pests, weeds and plant diseases.

MAKING THE GIANT MOLECULES is increasing the demand for other products made by Republic. ENDURO Stainless Steel is the must metal in processing equipment because of its corrosion-resistance, heat-resistance, high strength, cleanability, inertness, long life and low ultimate cost. In severe corrosive applications Republic Titanium is ideally suited for valves, pumps, heat exchangers, pressure vessels. Republic SRK Plastic Pipe for chemical waste and process lines is providing substantial savings in material, installation and replacement costs. It's highly resistant to a long list of corrosive liquids and gases. Mail coupon for more facts on these Republic products.

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Send more information on:
☐ ENDURO® Stainless Steel
☐ Titanium ☐ RSK Plastic Pipe

Name_____ Title_____

Company_____

Address_____

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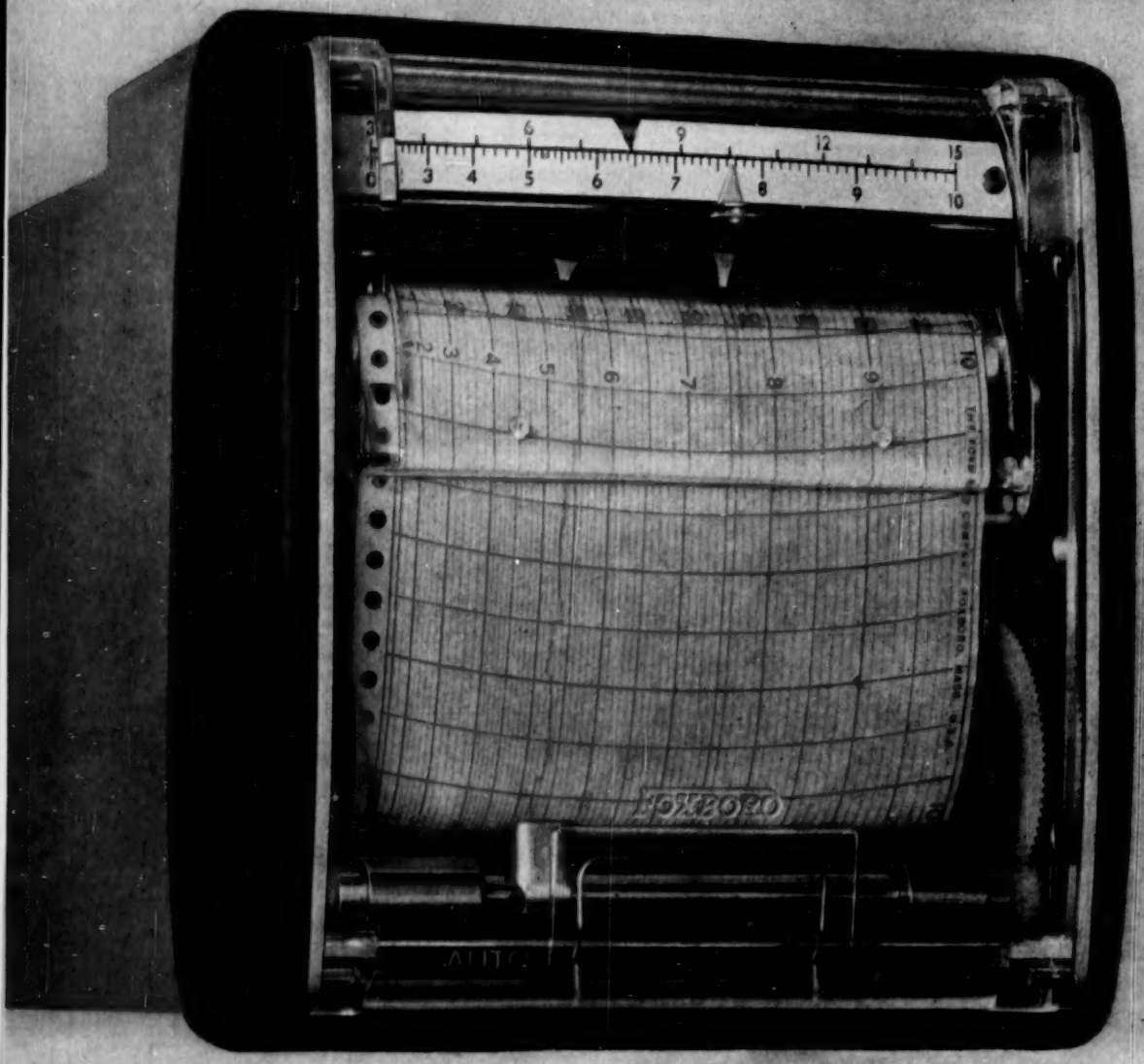
STEEL

and Steel Products

FOXBORO
adds new convenience features to CONSOTROL* Recording Control Stations



Shown actual size

*Reg. U. S. Pat. Off.

– further "operating ease" combined with accuracy – readability – top performance

3-pen recording, angle mounting, indicating tear-off bar . . . just a few of the new convenience features you'll find in Foxboro Consotrol Recorders and Recording Control Stations.

But these new operating benefits are only part of the story. Additional control functions are handled easily with Consotrol Instruments. Auto-Selector control — the control of related variables through a common valve is now possible with Consotrol small-case panel instrumentation, as is centralized control of batch processes.

With their new, exclusive operating conveniences and process control functions, Foxboro Consotrol Recording Control Stations, now, more than ever, provide you with superior centralized recording and control. You'll find they maintain the highest standards of precision and dependability — are the simplest to maintain.

Write Foxboro for full details. Ask for Bulletin 13-18A. The Foxboro Company, 1012 Norfolk St., Foxboro, Mass., U.S.A.

FOXBORO

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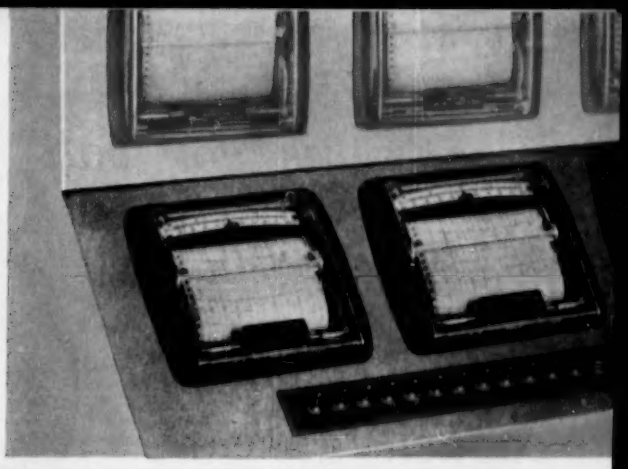
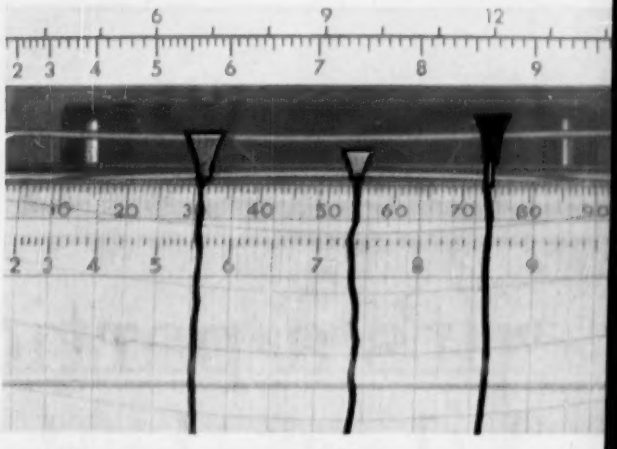
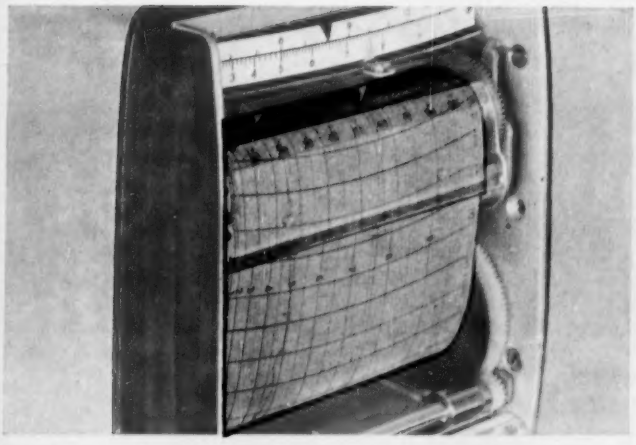


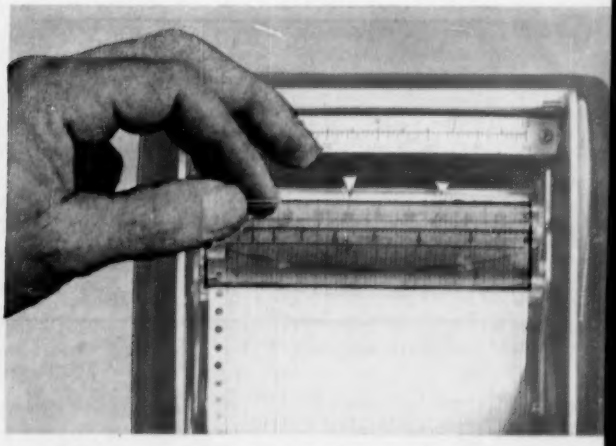
New – angle mounting Now you can panel-mount your Consotrol Recording Control Stations as much as 75° from the vertical, giving you more usable panel space closer to the floor. Operator can read lower instruments without stooping.



New – 3-pen recording 3 continuous records are simultaneously recorded on one chart, with this new Foxboro 3-pen recorder. Related measurements can be grouped for quick, easy comparison . . . valuable panel space is saved.

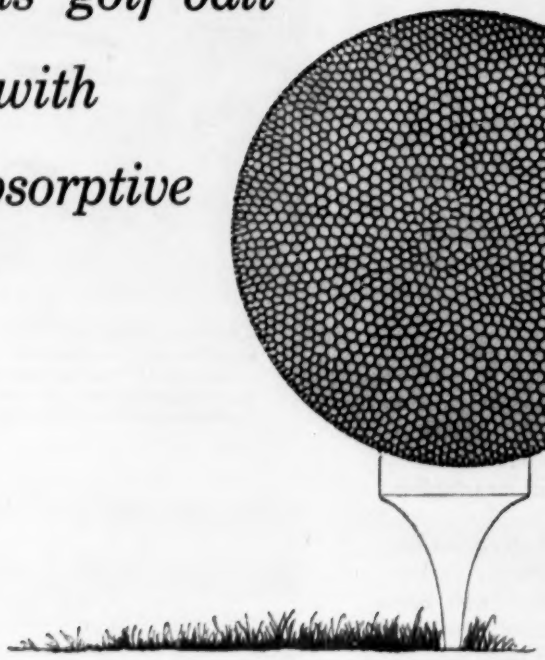


Full scale chart The Foxboro 4-inch Consotrol chart, with the same length scale as a 12-inch circular chart, travels vertically from the top. No sagging . . . no misalignment. Pen travels in same direction as circular-case recording pen.



New – indicating tear-off bar Ideal for multi-pen control stations and recorders, this new "see-through" plastic tear-off bar has indicating scales to read second and third variables. Scale colors match pen colors – makes following a process a cinch for the operator.

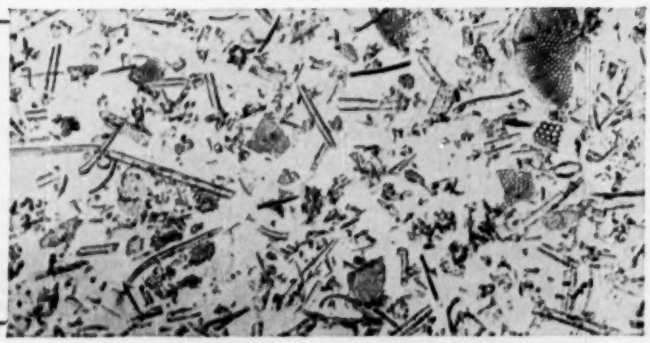
What's this "golf ball" got to do with greater absorptive capacity?



This magnification shows just one of the hundreds of different shaped particles found in Celite diatomaceous earth. Its genus is *Coscinodiscus* which means "disc-shaped sieve." Its species designation is *Radiatus* which refers to its radial structure. *Coscinodiscus Radiatus* is one of the more common marine diatoms and resembles a "golf ball" only when greatly magnified.

It's a particle of CELITE that absorbs more than

The secret of diatomite's remarkable properties is shown in this photomicrograph. The infinite variety of particle shapes and sizes gives Celite diatomite its exceptional performance characteristics in a wide range of process applications. The large percentage of voids both between and within particles like the "golf ball" provide porosity for high absorption.



Johns-Manville CELITE

Helps polishes soak up oil and dirt. In polishes for silver, other metals, glass and airplanes as well as automobiles, Celite absorbs residual oil, dirt and other solid matter. In addition, Celite imparts a delicate non-scratching polishing action.

Provides free-flowing fertilizers for uniform coverage. In ammonium nitrate fertilizers, highly absorbent Celite particles form a protective coating which helps prevent contact between crystal faces . . . thereby minimizing caking and assuring good flowability.

Controls viscosity in adhesives for corrugated paper. For precise control of viscosity and surface penetration, manufacturers of many types of adhesives rely on Celite's excellent absorptive capacity.

-the diatomite mineral filler twice its weight of liquid

Mix 100 cc of water with 100 grams of Celite* . . . the water is so completely absorbed that the mixture exhibits all the properties of a dry powder. This demonstration is visible proof of the high absorptive capacity of Celite diatomite fillers. Actually it will absorb 2 to 3 times its own weight before reaching its liquid holding limit. The reason is that approximately 93% of a given volume of Celite is composed of air spaces or voids. Despite its highly porous nature, however, Celite does not absorb moisture from the air.

In addition, Celite has many other unique properties which give it wide application as a mineral filler. Its high bulk—a cubic foot weighs only ten pounds—reduces outage in packaged powder products and provides the needed bulking action in many other formulations. The irregular shape of the particles and their hard silica structure adds reinforcing strength to paints and plastics. Other uses include concrete, insecticide diluent, paper and as a source of silica in "water glass" and "lime-silica" insulating materials.

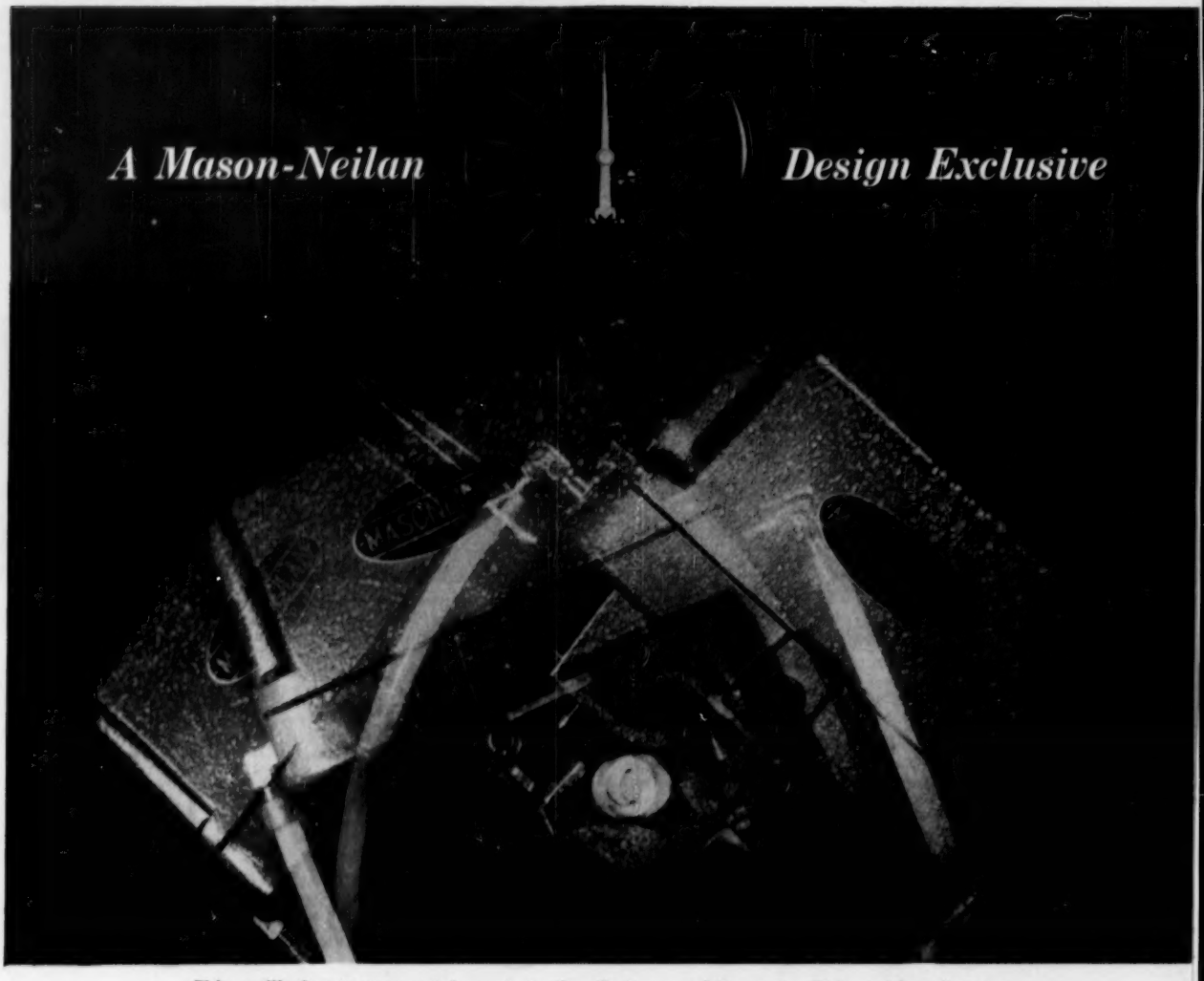
Produced from the world's purest commercially available diatomite deposit, Celite comes in a wide range of grades. Each grade is carefully controlled for complete uniformity.

Ask your nearest J-M Celite engineer to tell you how Celite can help solve your formulation problems. He's backed by Johns-Manville's extensive research facilities and years of practical diatomite experience. Call him today or write Johns-Manville, Box 60, New York 16, New York. In Canada, write Port Credit, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

Industry's most versatile MINERAL FILLER

JOHNS-MANVILLE JM PRODUCTS



This oscillating test mount demonstrates the effectiveness of Masoneilan "Balanced Beam" design. Output pressure does not change, regardless of transmitter position.

Balanced beam construction also shows how the entire assembly has been compactly designed. Adjustment on front of beam provides means of synchronizing output range with the primary element span. Damage protection is provided for primary element, by beam stop and overrange feature; for compensating bellows by built-in stops; for entire unit by rugged, weather-proof case.

Masoneilan Pressure and Temperature Transmitters use Balanced Beam to Prevent Zero Shift

The new Masoneilan Transmitters feature a distinctive balanced beam design which eliminates positional error

In addition, these transmitters offer several other important design advances. Unit construction simplifies change or removal of subassemblies; All adjustments are visible and accessible; Large pilot capacity insures fast operation with long transmission lines; and Unit is compensated for ambient temperature and barometric pressure.

Write for Bulletin

Complete information and data on this new instrument is now available. Write for your copy or ask for details at your nearest Mason-Neilan office.

MASON-NEILAN

Division of Worthington Corporation

67 NAHATAN STREET, NORWOOD, MASS.

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Appleton • Birmingham • New Orleans • Seattle • Jacksonville
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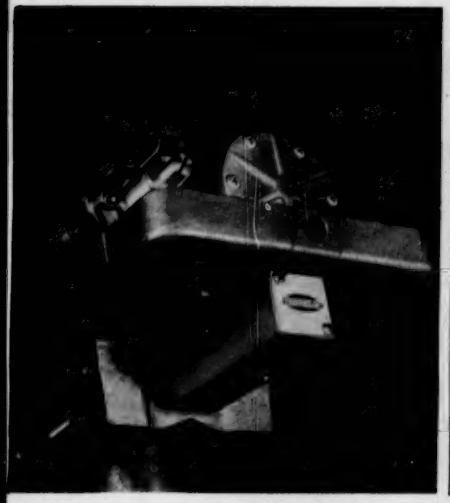
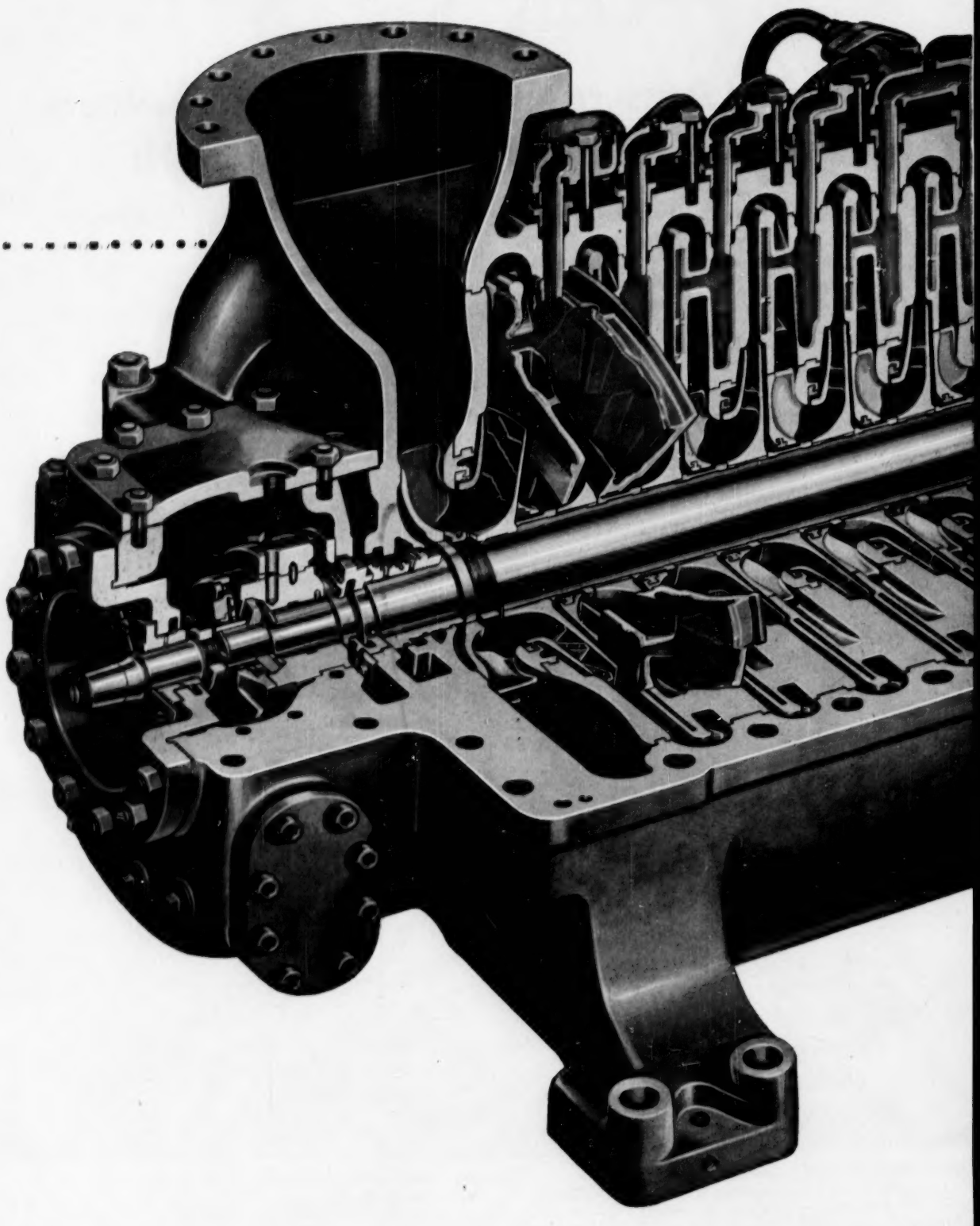


The derivative unit compensates for lags in the thermal system. It can be quickly added on the underside of base plate, and requires no tubing or fittings. Mounting block attaches to flat surface or forms clamp for pipe.

Unit Subassembly construction permits simplified removal or change of primary element; compensating bellows; feed-back bellows; pilot; range span adjustment; derivative unit; and gasketless nozzle — any or all without disturbing beam assembly in any way. Integral Receiver Gage is another Masoneilan feature — can be mounted directly on base plate without external connections.



CLARK

Diaphragm Cooling

- **Minimizes polymer formation**
- **Slashes horsepower requirements**
- **Greater safety handling hazardous gases**
- **Reduces capital investment**

Clark double-wall diaphragm cooling is the simplest, safest, and most effective way to intercool a multi-stage centrifugal compressor. Furthermore, polymer formation is minimized in the compressing of unsaturated hydrocarbon gases by the use of diaphragm cooling. It is a simple, economical method of maintaining gas temperature at the desired level in the capacity range of 1,000-30,000 CFM.

Power savings are an additional benefit of diaphragm cooling. The savings range from 20% on 15 molecular weight vacuum gas compressing applications to 5% for 110 psig. air compressors. Reduced installation and operating costs result.

Minimum capital investment is realized another way. Applications involving high compression ratios such as gas recovery and 120 psig. or less air compressors can be handled in a single case.

Diaphragm cooling also assures maximum safety when compressing oxygen, acetylene, and other difficult gases. Internal surfaces are always cool. Danger from potential hot spots is highly remote.

Clark builds a complete line of multi-stage centrifugal compressors and in many instances a gas turbine to drive them. Your nearest Clark representative has all the facts.

CLARK BROS. CO. OLEAN, N. Y.

One of the Dresser Industries

Offices in Principal Cities Throughout the World

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Centrifugal Compressors

Gas Turbines

Try this Taylor answer for tough

NO POCKETING...NO PURGING

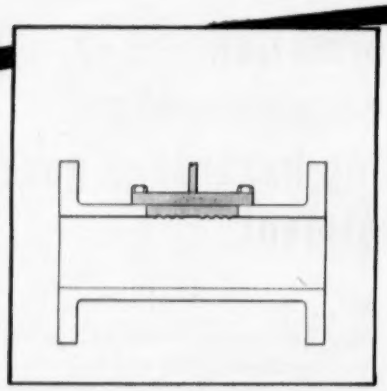
TYPICAL APPLICATIONS

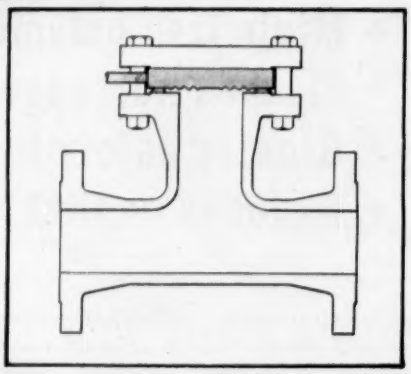
Flow Measurement of • Salt Slurries • Viscose • Liquid Sulphur • Sulphuric Acid • Caustic Solutions • Pulp Solution • HF Alkylation

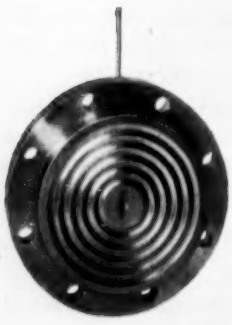
Taylor furnishes all required types of differential producing devices—including concentric, eccentric, segmental or quadrant orifice plates.

Level Measurement on • Caustic Evaporators • Emulsified Asphalt Storage Tanks • Batch Stills • Pharmaceutical Crystalizers

Differential Pressure Measurement • Fractionating Columns • Pumps • Filters







Type 95 flange (*left*), for use with chemical tee. For flow installations where diaphragm is flush with the inside of pipe, so that process fluid imparts a scouring action. Also for liquid level requiring flush installation. Maximum pressure 300 psi.

Wafer type sensing element (*right*), for use with standard 3" ASA flange, where diaphragm need not be flush mounted, e.g., corrosive flow or liquid level measurement. Standard diaphragm material, for both types, 316 Stainless Steel; alternates available. Maximum pressure 1500 psi.

Taylor Instruments

Flow and Level measurement...

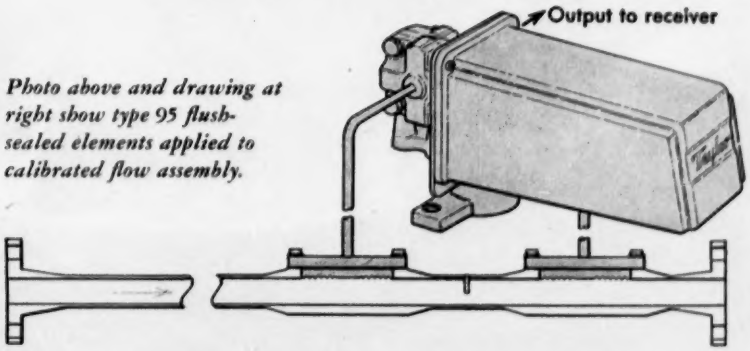
...NO PLUGGING... WITH THE NEW

205T VOLUMETRIC DIFFERENTIAL PRESSURE TRANSMITTER

Here at last is an economical way to eliminate purge and seal problems. The Taylor 205T Flow and Liquid Level Transmitter never has to be purged of deposited material and never suffers from corrosion, because it is completely isolated from the process material. The pressure-sensitive diaphragms may be installed flush with the inside of the pipe or tank in a variety of mountings. The temperature limit is 300°F. at the diaphragms.

Accurate, sturdy, dependable and low-cost, this latest addition to the Taylor family of transmitters can solve your most difficult flow and liquid level measurement problems. Ask your Taylor Field Engineer for full details, or write for **Bulletin 98281.**
Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada.

Photo above and drawing at right show type 95 flush-sealed elements applied to calibrated flow assembly.



VISION • INGENUITY • DEPENDABILITY

MEAN ACCURACY FIRST

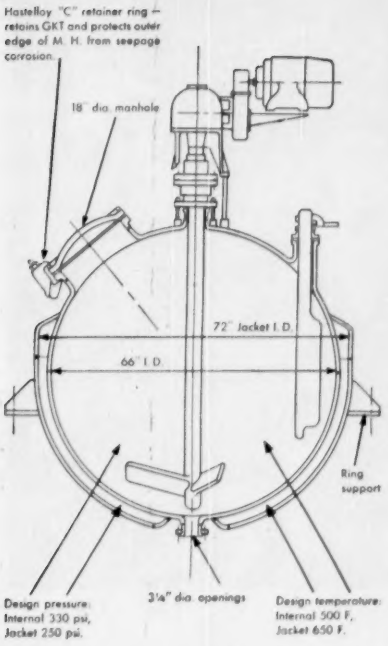
TOMORROW'S ENGINEERING TODAY!

the spherical glass-lined

54

December 1957—Chemical Engineering

reactor is here!


Hastelloy "C" retainer ring — retains GKT and protects outer edge of M. H. from seepage corrosion.
18" dia. manhole
72" Jacket I.D.
66" I.D.
Ring support
Design pressure: Internal 330 psi, Jacket 250 psi.
3¼" dia. openings
Design temperature: Internal 500 F, Jacket 650 F.

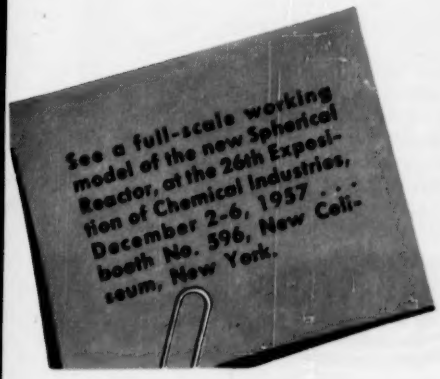
Designed to operate at internal pressures in excess of 300 psi

A Glascote first!

No longer need processing be limited to 200 psi! This is the kind of process engineering you'd expect from Glascote. The 500-gallon (nom. capacity) reactor shown is designed to operate at 330 psi internal pressure and 250 psi in the jacket.

- Large capacity — sphere shape permits thinnest metal wall possible to contain a given amount of liquid under pressure.
- Shorter agitator shaft — reduces drive maintenance, shaft bending normally encountered in large volumes.
- One main seam — minimum of welding. Full X-ray quality. Ring-type support.
- Higher vaporization rates — less foaming, due to larger liquid surface area.
- Higher pressures — both internal and external for larger units.

And . . . like all Glascote products, you benefit from 100% protection afforded by Glascote chemical-resistant, acid-alkali glass. Write for Bulletin MG-100 offering complete specifications.


See a full-scale working model of the new Spherical Reactor, at the 26th Exposition of Chemical Industries, December 2-6, 1957 . . . booth No. 596, New Coliseum, New York.

Glascote®

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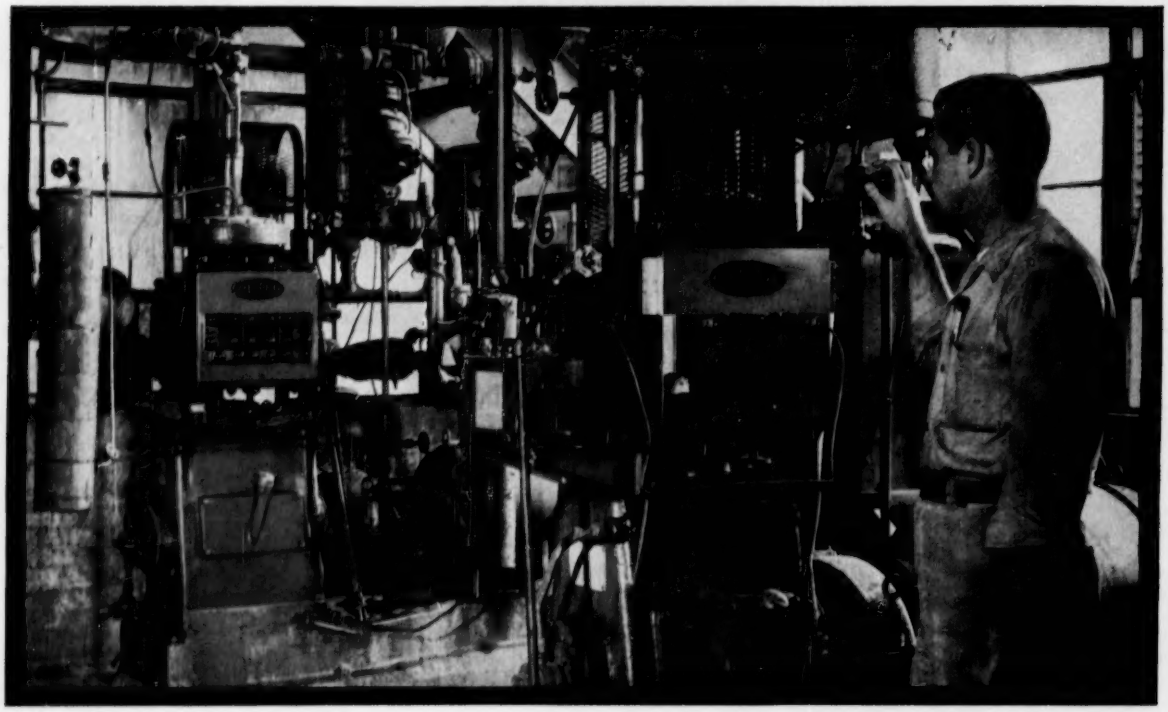
EMERY INDUSTRIES LICKS TOUGH PROBLEM:

How to pump fatty acids 24 hours a day, 7 days a week, and cut maintenance costs!

Around-the-clock hydrolysis produces fatty acids from animal fats, tallow, palm, soybean, cottonseed and corn oils at Emery Industries plant in Cincinnati, Ohio. Pumps work on hot corrosive fatty materials 24 hours a day, seven days a week, and maintenance used to be a costly problem. Packings had to be replaced far too often. Valves needed frequent refacing. Wear of plungers was excessive.



How Emery solved the puzzle: Looking for an answer to the problem of excessive downtime and maintenance, Emery conferred with several pump manufacturers. Aldrich was the only company to offer a pump better in both design and materials . . . the fluid end being of stainless steel. Original, ineffective pumps were immediately replaced with Aldrich Triplex Pumps.

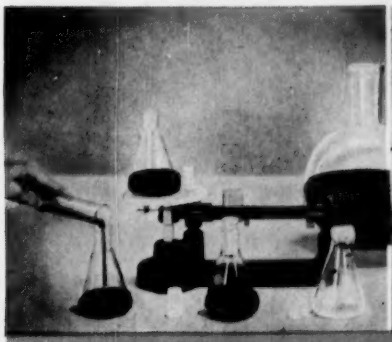
Result: Two Aldrich Pumps have pumped raw materials on a continuous basis since 1948. Two more were installed for additional capacity in 1954. Maintenance costs have been reduced substantially. Downtime has decreased to a minimum. Operating efficiency is now at an all-time high and quality of processing has improved. We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

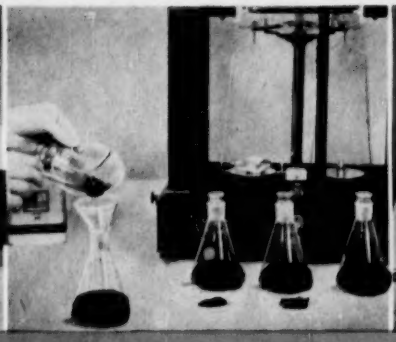
DARCO

CHEMICALS DIVISION, ATLAS POWDER COMPANY, WILMINGTON 99, DELAWARE • Atlas Powder Company, Canada, Ltd., Brantford, Ontario, Canada

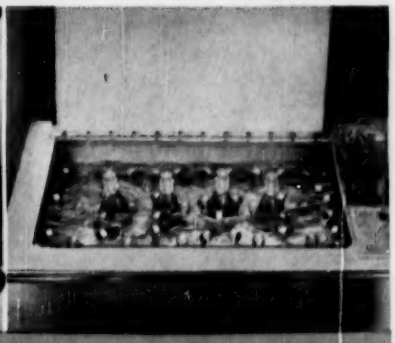
Simple tests in your lab determine dosage of DARCO activated carbon to solve your purification problem



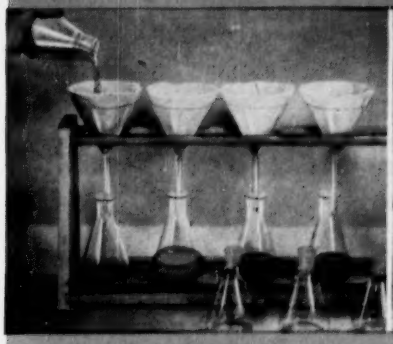
1 *Measure out four equal (100-gm or 100-ml.) samples of liquid to be purified . . . to establish 3 points on adsorption curve for your liquid.*



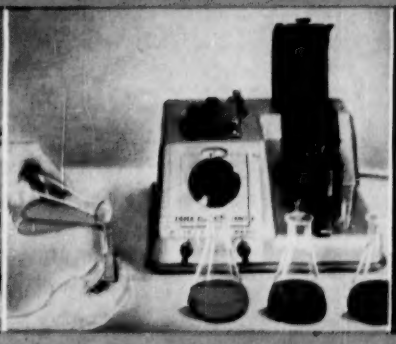
2 *Add 0.5, 1.0 and 1.5 grams of DARCO activated carbon to samples 1, 2 and 3 respectively. The number 4 sample is your untreated control.*



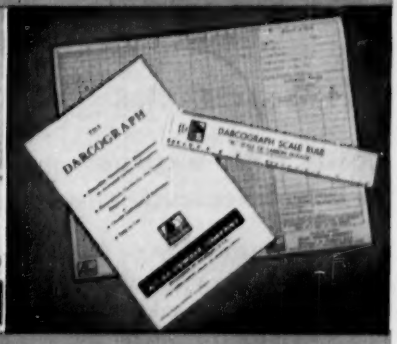
3 *Agitate all samples for one-half hour in water bath at a safe temperature for your liquid. Motor-driven agitator assures uniform shaking.*



4 *Filter out carbon from samples 1, 2 and 3. Collect sample only after filtrate becomes clear. For viscous liquids you may need to apply suction.*



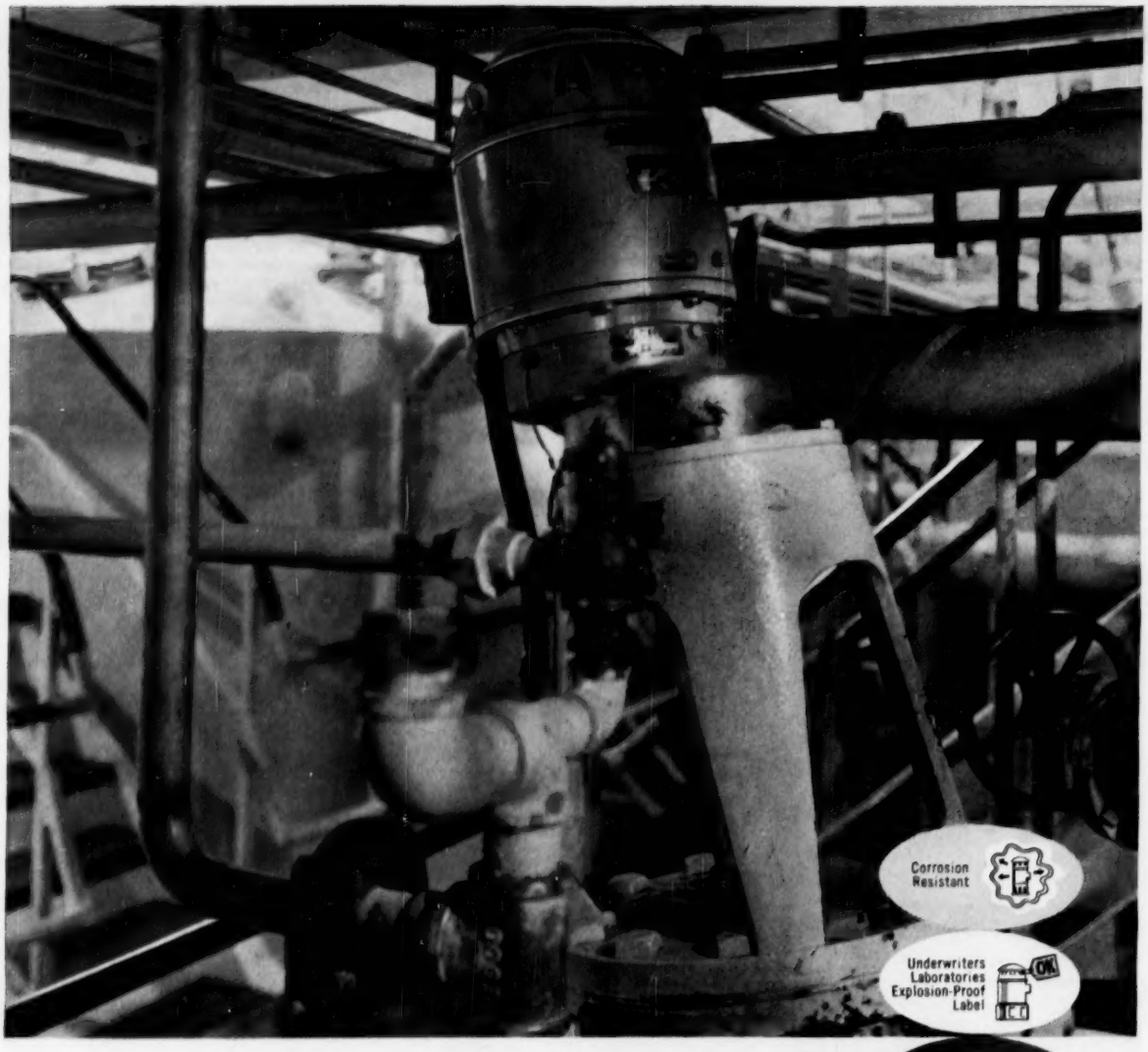
5 *Measure residual color of all samples with a colorimeter. For other purification uses, measure desired characteristic (% impurity, for instance).*



6 *Plot color adsorption vs. carbon dosage on a Darcograph. Read off the dosage of DARCO needed to get the residual color you require.*

You can make these tests easily in your own laboratory, using equipment which you have on hand. By varying temperatures, contact time and dosage ranges, you can establish optimum treatment conditions.

Write to Atlas for a Darcograph, instructions on its use, and samples of Darco for your evaluation. Give us the details of your specific problem, and we can recommend the most effective Darco grade for your particular use . . . and thus save you testing grades that our experience indicates are less suitable.



This motor battles corrosion

Louis Allis explosion-proof chemical motors are ideal for chemical, petrochemical, plastics, and paint installations.

It takes a motor designed for the chemical industry to withstand the abuse of this corrosive service. The 2 hp totally-enclosed fan-cooled explosion-proof motor shown above on a mixer drive is typical.

Few applications are subjected to such extreme environmental conditions. To meet them, Louis Allis chemical motors are built with cast-iron housings to provide exceptional corrosion resistance to etching vapors and corrosive gases. Motor shrouds are stainless steel, fans are bronze. Even the nameplate is made of stainless steel to preserve important motor information like bearing sizes and the wiring diagram for simplified servicing.

Louis Allis insulation is designed to withstand exposure to acids, alkali, or moisture to assure you of dependable service. Locked bearing construction prevents rotor drift . . . extends bearing life.

We'll gladly offer expert field application service. Contact your Louis Allis District Office or write The Louis Allis Company, 447 East Stewart Street, Milwaukee 1, Wisconsin. Ask for Bulletin 1050.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

How to evaluate materials of construction for the chemical plant

Choosing materials of construction for chemical-industry equipment is a complex job. The first step toward the solution of a new problem is the analysis of all the requirements that can be anticipated. If they indicate one or more of the properties shown, chances are that Crucible *stainless* steel is the most practical choice you can make.

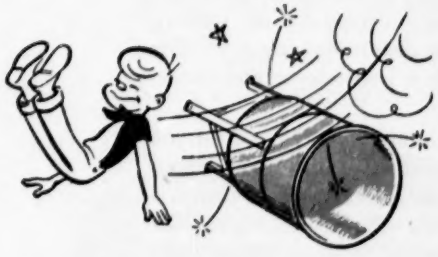
RESISTS CORROSION – Stainless is almost impervious to attack by oxidizing acids like nitric acid. It resists strong alkaline solutions, and many other chemical compounds.

PREVENTS CONTAMINATION – With stainless there's no pickup of metallic ions or deterioration in the product. Stainless stays out of the process solution.

CLEANS EASILY–Even for the most rigorous cleaning problem–that of decontamination to remove radioactive matter–stainless is chosen decisively over other materials.

WITHSTANDS TEMPERATURE EXTREMES – At very high temperatures, stainless stays strong. At very low ones, it does not become brittle as other metals may.

PROVIDES GREAT STRUCTURAL STRENGTH –Stainless is about 50% stronger than mild steel. It permits lightweight, durable construction of chemical processing equipment.



RESISTS WEAR AND ABRASION – Erosive and abrading action makes the surface of stainless harder. It's ideal for mixers, chutes, bins and piping.

ALLOWS COMPLEX FABRICATION–Stainless can be cut, bent, drawn, welded, machined, forged, spun, riveted, cast–fabricated by all the common metal-working processes. Stainless imposes no restrictions on equipment design.

Crucible metallurgists have had considerable experience with stainless in chemical applications. They will be happy to work with you to make the best, most economical use of stainless in your plant. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

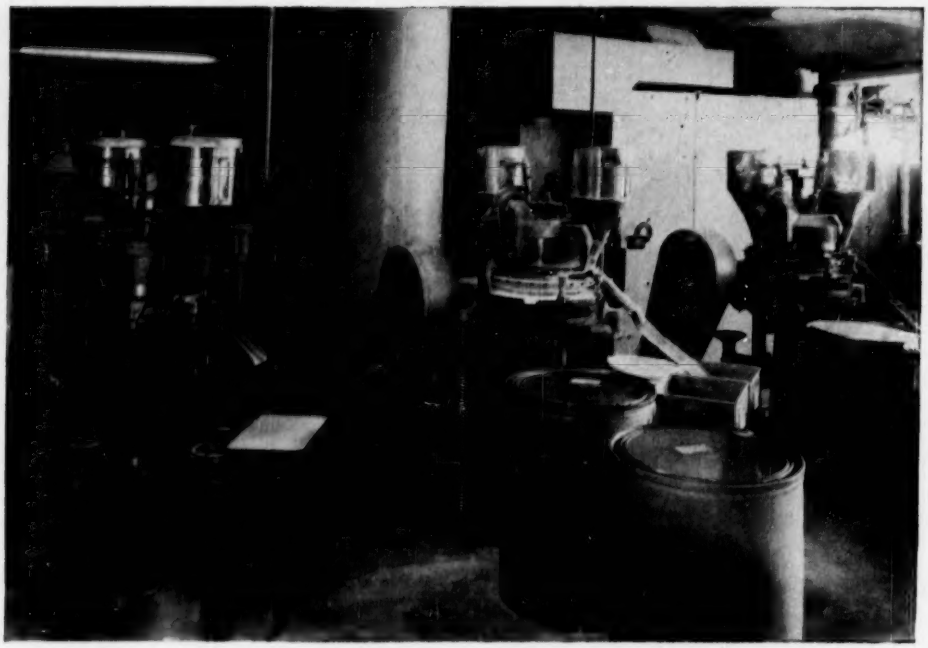
Send for a copy of the 44-page booklet "Making the Most of Stainless Steels in the Chemical Process Industries". It's packed with data you can use.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor – Railway & Power Engineering Corp., Ltd.

With a LECTRODRYER* DRYing suits the process



Night and day, seven days a week; that's the schedule this Lectrodryer works, holding the humidity constant in this tableting room.

Your materials are allergic to moisture. But the process calls for grinding, screening, evaporating, sublimating, tableting, conveying or storing them in an atmosphere that's soaking wet. You can DRY that air with a Lectrodryer and cancel out that variable.

Your materials deteriorate when heated, so you can't use that method of driving off unwanted moisture. A Lectrodryer is an adsorbent drier—makes air, gases and organic liquids truly DRY without destructive heating. Quality is preserved.

There's a Lectrodryer for every DRYing purpose—described in Bulletin 109. For a copy, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 303 32nd St., Pittsburgh 30, Pennsylvania.

*Registered Trademark U. S. Pat. Off.

Lectrodryer

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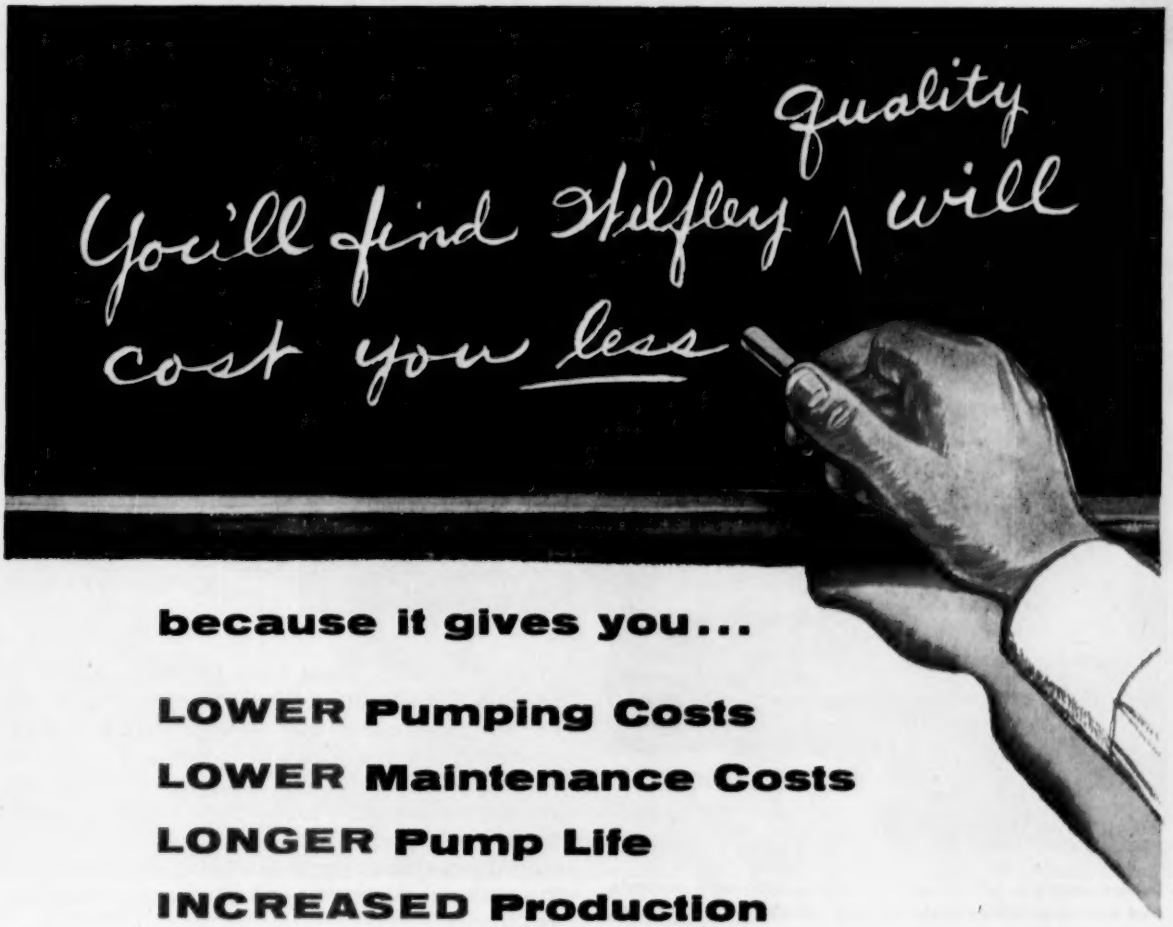
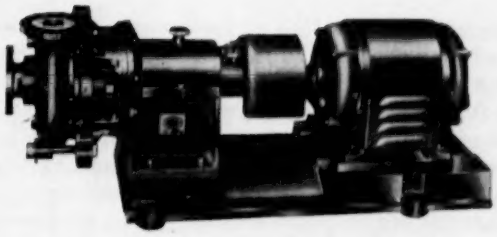


because it gives you...

LOWER Pumping Costs
LOWER Maintenance Costs
LONGER Pump Life
INCREASED Production

When you buy quality, Wilfley quality, you buy *superior* performance.
You start *saving* money the moment a Wilfley Acid Pump goes into action.
Let Wilfley solve your pumping problem.
Write, wire or phone.



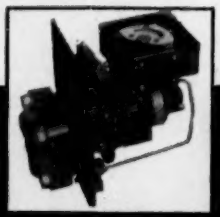
Wilfley Sand Pumps
"Companions in Economical Operation"
Wilfley Acid Pumps

WILFLEY
ACID PUMPS

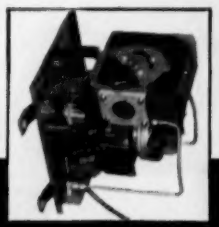
Individual Engineering on Every Application

REPUBLIC'S new family of NULL-BALANCE-VECTOR* PNEUMATIC INSTRUMENTS

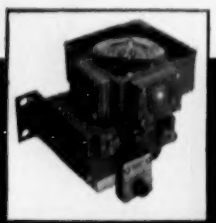
TYPE VP
Pressure Transmitter
Standard Ranges
0-1.5" to 0-5000 psi



TYPE VDP
Differential Transmitter
Standard Range
0-15 to 0-300" H_2O



TYPE VT
Temperature Transmitters
Standard Range
0-100° to 0-1000° F.



TYPE VC
Control Transmitters

* **Design principle which permits making extremely accurate and sensitive components that are compact, versatile and interchangeable.**

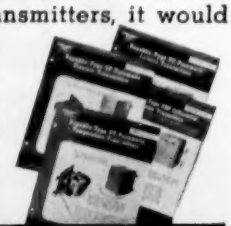
Republic's new line of pneumatic instruments includes pressure, differential pressure, temperature and control transmitters. Controllers that feature repeatable reset rate, less than 0.05% dead band and proportional band adjustment from 2 to 500%;—differential pressure transmitters with 20 to 1 range adjustment;—pressure transmitters of ±0.5% accuracy; and temperature transmitters with 10 to 1 range adjustment show the flexibility as well as the compactness, lightweight and accessibility of these instruments.

THE NULL-BALANCE-VECTOR PRINCIPLE

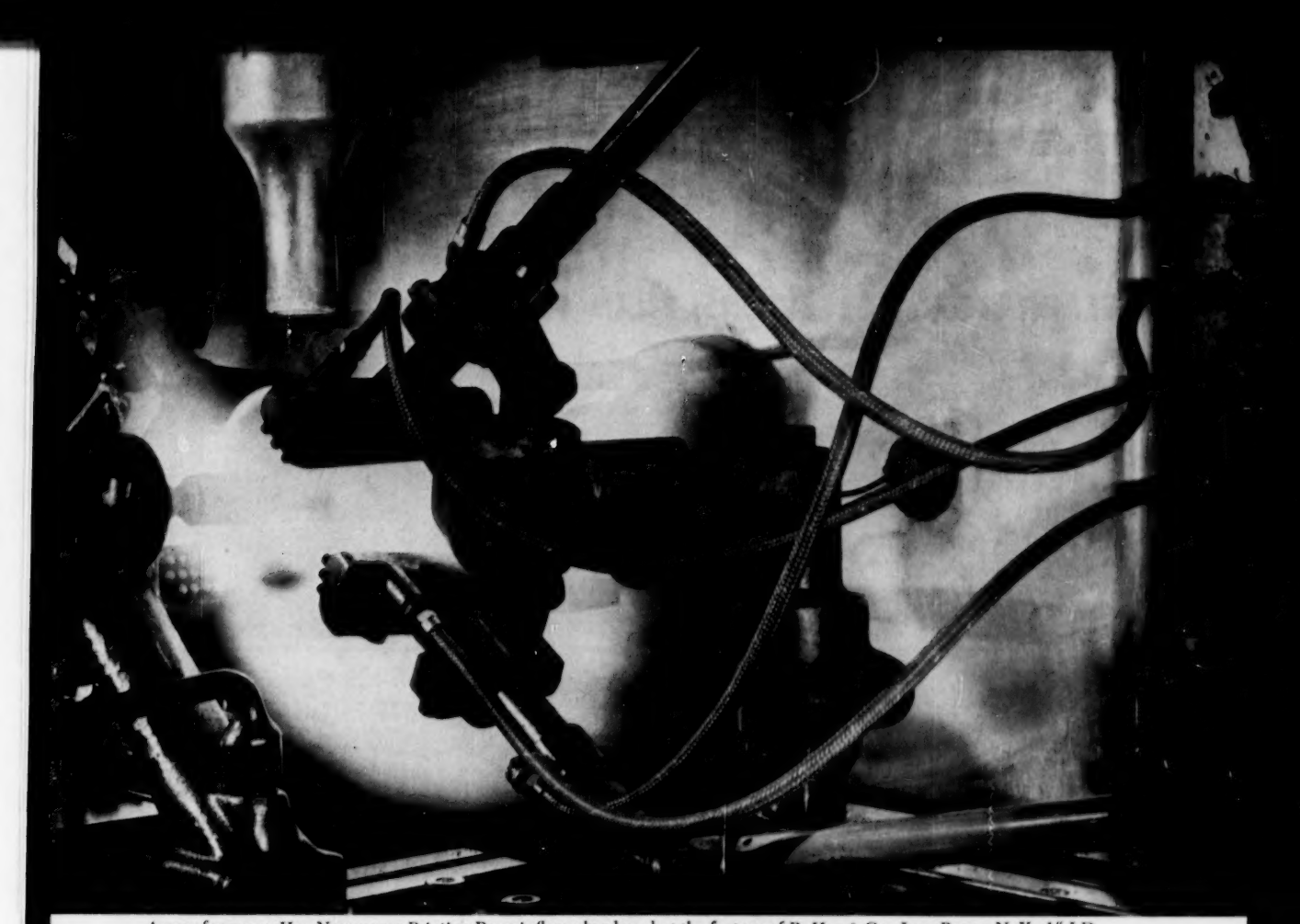
In terms of calibration, the null-balance-vector principle means that the span of any pneumatic instrument in the line can be varied at will . . . merely use a screwdriver and a reference . . . without re-setting zero. In terms of theory, the null-balance-vector principle means that the proportion of an input force (from a measuring bellows, bourdon tube, diaphragm, etc.) balanced by the pneumatic circuit can be varied by changing the angle at which that force acts on other links in the system. Hence, without changing air supply pressure or the measuring bellows, bourdon tube or diaphragm, the same output signal pressure range can reflect a measured input signal range that can be changed as much as 20-to-1.

Republic's new family of pneumatic instruments was developed in parallel programs that use the greatest possible number of common components. The result: High interchangeability of parts, even between instruments performing entirely different functions. Such design foresight has made the spare parts and training problems extremely simple. And Republic's null-balance-vector design means that full-range operation involves virtually no motion . . . and virtually no wear.

If you want the best sensitivity, accuracy and reliability in pneumatic transmitters, it would pay you to get full details on all four of Republic's new family of Null-Balance-Vector Pneumatic Instruments. Write for descriptive folios on each type, now.



REPUBLIC FLOW METERS CO.
A Subsidiary of Rockwell Manufacturing Company
2240 Diversey Parkway • Chicago 47, Illinois



A gear for a new Hoe Newspaper Printing Press is flame-hardened at the factory of R. Hoe & Co., Inc., Bronx, N. Y. 1" I.D. seamless bronze American Flexible Metal Hose on the flame hardening machine, shown here, conveys acetylene gas.

Design Problem:

Leakproof gas lines that must flex
. . . withstand heat from outside
. . . corrosive attack from within

Answer:

American Metal Hose

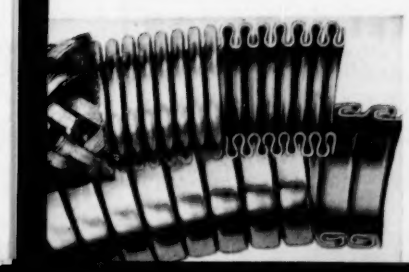
This machine hardens, brazes, and heat processes metal products and parts. The flame heads are adjustable; so the hoses conveying the fuel gas must be flexible. And they must be tough! Corrosive gas attacks them from the inside. High heat is a constant enemy on the outside. Yet they must be leakproof. For safety's sake, they must not fail.

The engineers found the right answer: American Flexible Metal Hose. It delivers more service hours per dollar!

Available in wide range of diameters in bronze, brass, aluminum, steel, monel, stainless steel and other metals—American Flexible Metal Hose is being used by countless manufacturers to convey almost every conceivable gas and liquid . . . to absorb vibration . . . absorb expansion and contraction in lines due to temperature changes . . . facilitate installation, especially in cramped spaces . . . to solve the problem of misalignment.

American furnishes flexible metal and Teflon connectors to your specifications . . . ready for immediate installation. Consult your nearby American Metal Hose representative for engineering help when planning your next job. Just released! New 64-page catalog chock-full of useful information on flexible metal hose and tubing. Write for your free copy: The American Brass Company, American Metal Hose Division, Waterbury 20, Conn.

57174



BASIC TYPES

Seamless corrugated and Strip-wound. Both types available in a wide range of sizes and styles in any workable metal. Furnished with or without end fittings attached.

WHEREVER CONNECTORS MUST MOVE

AMERICAN

FLEXIBLE METAL HOSE AND TUBING

AN **ANACONDA**® PRODUCT

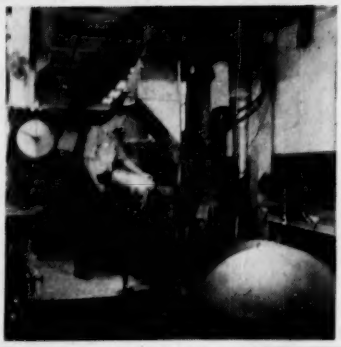
DUST and FUME topics

WHEELABRATOR CORPORATION Mishawaka, Indiana

WHEELABRATOR® COLLECTORS TURN PROBLEMS INTO PROFIT

Save $10,000 Yearly Ventilating Banbury Mixers at Lord Mfg. Co.

Lord Mfg. Co. of Erie, Pa., operates 2 Banbury mixers to mix carbon black, sulphur and other materials with rubber stocks. Ventilation of each mixer by a Wheelabrator Dustube Collector keeps carbon black and other material from escaping into the air. Because this material is collected in the dry state, it can be returned to the batch. Besides the product savings of $10,000 yearly, the return of the material also insures proper mixture throughout the batch cycle to maintain quality. Better working conditions are also provided.



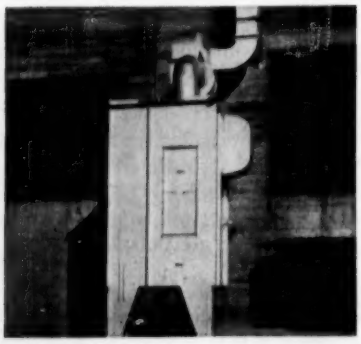
'Super-Clean' Air at Low Cost

- *New dust control principle is efficient, economical*
- *"Ultra filtration" gives service 24 hours a day*
- *"Ultra filtration" ends instrument repair*

"ULTRA FILTRATION" with Wheelabrator Dustube Collectors uses an inexpensive filter aid to collect fine atmospheric dust at low cost and with unusually high efficiency.

* * *

THERE IS CONSTANT demand for super-clean air in the hammer mill room at Columbia-Geneva Steel



Div. of U.S. Steel Corp. Two 500 H.P. synchronous motors operate 168 hours a week. Wheelabrator "Ultra Filtration" has provided clean air with virtually no maintenance costs in the first year.

* * *

INSTRUMENTS in the sinter plant control room which is in a very

dusty location at Columbia-Geneva required regular costly repairs until Wheelabrator "Ultra Filtration" was installed. Dust has ceased to be a problem in operation and maintenance of recording and control instruments since installation of Wheelabrator "Ultra Filtration."

* * *

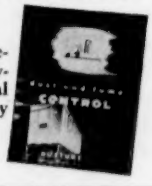
"ULTRA FILTRATION" is ideal for electrical control rooms, laboratories, manufacturing areas, etc. Write today for complete details.

SAVINGS PAY EQUIPMENT COSTS at CHEMICAL CO.

Installed to regulate dust that was a nuisance to Cotton States Chemical Co. and its neighbors in Monroe, La., three Dustube Collectors are paying for themselves in values collected and returned to the products. More than $100 worth of Benzene Hexachloride, DDT, Toxaphene and Aldrin is saved daily.

SEND FOR THIS CATALOG

For more complete details on Dustube savings in the chemical industry, write today for Catalog 372C.



WHEELABRATOR
CORPORATION
347 South Byrkit St., Mishawaka, Ind.

TOMORROW'S PRODUCTS TODAY...THROUGH ENJAY PETROCHEMICALS

Basic ingredients for LACQUER finishes that show off the finest cars!

Good looking cars look even better with high-gloss lacquer finishes. Enjay solvents make superior lacquers because of their high purity, uniform boiling range, and carefully controlled evaporation rates.

Enjay petrochemicals are widely used by manufacturers in the formulation of many other surface coating products: vinyl lacquers and water-base paints; lacquer, enamel, paint and varnish removers.

The recently expanded Enjay Laboratories are fully equipped to handle surface coating problems related to the application or use of any Enjay petrochemical. Write or call for more information.

Enjay offers a widely diversified line of petrochemicals for industry:

ALCOHOLS & SOLVENTS: Lower Alcohols, Oxo Alcohols, Ketones and Solvents; OIL & FUEL IMPROVERS: Detergent-Inhibitors, V-I Improvers, Oxidation-Inhibitors; CHEMICAL RAW MATERIALS: Olefins, Diolefins, Aromatics; ENJAY BUTYL RUBBER & VISTANEX.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 W. 51st STREET, NEW YORK 19, N. Y. Akron, Boston, Chicago, Detroit, Los Angeles, New Orleans, Tulsa

It's the Nash!

The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature Automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

312 WILSON, SO. NORWALK, CONN.

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

Jobs for plastisols become bigger ...and still BIGGER!

Tank lining service that reduces costs

"Very good", reported the inspector at a large chemical company. He was examining the interior of one of their tank cars coated with phenolic Unichrome Lining B-124. Twenty-two trips in contact with highly corrosive 92% phenol left little mark on the protective coating.

APPLICATION SERVICE

Companies using tank cars or tanks can benefit from this experience. Throughout the country, skilled firms, such as Metalweld, Inc., of Philadelphia, are prepared to apply linings to open or closed tanks. Now no company has to forego the maintenance-saving, cost-cutting protection of enduring Unichrome Tank and Drum Linings.

NOTE: Unichrome *Plastisol* Coatings provide durable linings resistant to alkaline chemicals for which phenolic linings are unsuitable. Send for data.

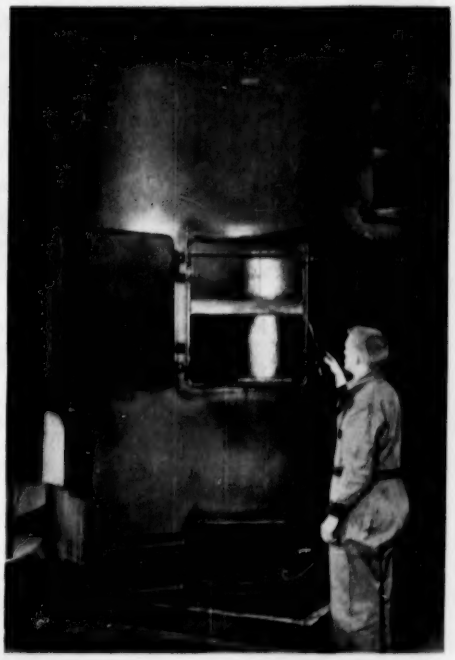
Unichrome is a trademark of Metal & Thermit Corp.

METAL & THERMIT
CORPORATION
General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
In Canada: Metal & Thermit—United Chromium of Canada, Limited, Rexdale, Ont.

Unichrome Coatings give heavy duty corrosion-protection

Interior of this large fume scrubber was sprayed with Unichrome Plastisol by Kaybar, Inc. The thick vinyl coating withstands acids, alkalies, and many other corrosives. Being pore-free and seamless, the Unichrome Plastisol lining is now preferred for many jobs where rubber or plastic sheet linings were used formerly.

Note that sheer size is no longer a hindrance in applying plastisols. Firms like Kaybar with ever-expanding facilities are located at key points and can handle big jobs economically, quickly and professionally.



Spark testing is used to check the continuity and thickness of Unichrome Plastisol Coating applied on fume scrubber by Kaybar, Inc., Birmingham, Michigan.

EXTRAORDINARY PROTECTION

Unlike sheet materials, plastisols also conform to irregular surfaces without air pockets. The coatings stick tight — a Unichrome primer-plastisol system averaging a bond strength of 50 to 100 pounds per inch. They have good flexibility to absorb mechanical shock, resist abrasion to a remarkable degree.

Sprayable Unichrome "Super 5300" Plastisol provides films up to 60 mils per coat. When an object can be dipped, use of Unichrome "Series 4000" Plastisols will form coatings up to ¼ inch thick in one coat.

Even ordinary metals gain phenomenal ability to stand up in severe service when protected with such heavy duty coatings. Engineers are thus finding in plastisols the means to improve life of equipment, solve problems of corrosion and wear, cut costs.

Send for detailed bulletins — or name of nearest applicator of Unichrome Plastisols.

STAINLESS STEEL

CORROSION-RESISTANT HEART FOR FOSTORIA* MAGNETIC PUMPS

Design of Fostoria's Dynapump called for a corrosion and wear resistant hollow shaft, with drilled slots in one end. As an integral part of the pump, dimensional accuracy was critical and the O.D. had to be ground to provide a smooth bearing surface. Damascus 7/8" x 16 gauge stainless welded tubing was selected — a wise choice for handling both corrosive and non-corrosive fluids.

**The Fostoria Pressed Steel Corporation, Fostoria, Ohio, manufacturers of pumps for industrial and residential use.*

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

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Stone & Webster Engineering Corporation has helped large and small companies in practically every country in the free world with specialized engineering services ranging from the development of a new welding technique to the design and construction of complete oil refineries.

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How to get more storage space with BLAW-KNOX Electroforged® Steel Grating

You can get additional badly needed storage space easily and economically in your present building simply by installing platforms of Blaw-Knox Grating. It fits easily, neatly around pipes, beams and machinery without any alterations to your building.

Maintenance costs are slashed into the bargain. There's nothing to wear, nothing to patch. Blaw-Knox grating is self cleaning too. No sharp corners to clog up with dirt, and you'll find painting is easy since all surfaces are easily accessible.

You get maximum open area for plenty of light and ventilation. What's more, its rigid one-piece construction means maximum structural strength and load bearing capacity.

Blaw-Knox Electroforged Grating for walkways, stair treads and floors is fabricated to your specifications to meet your own operating requirements. Complete data on all types is contained in Bulletin 2527. Write for your copy today.

BLAW-KNOX

BLAW-KNOX COMPANY

Blaw-Knox Equipment Division
Dept. C, Pittsburgh 38, Pa.

Newly designed
Type H Motor Control

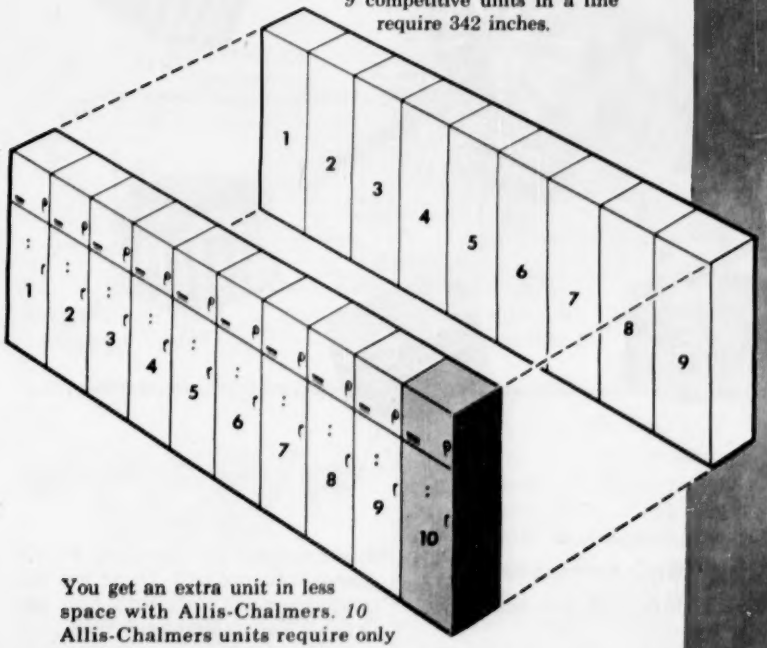
Saves valuable plant space

Newly designed Allis-Chalmers high voltage control units are only 34 inches wide. This means you can put 10 Allis-Chalmers cabinets in less space than required by 9 competitive 38-inch units. In addition, the narrower width means less space required for door swing. Result: You save a total of 2.36 sq ft of floor space per unit. On 10 units, this means a saving of 23.6 sq ft.

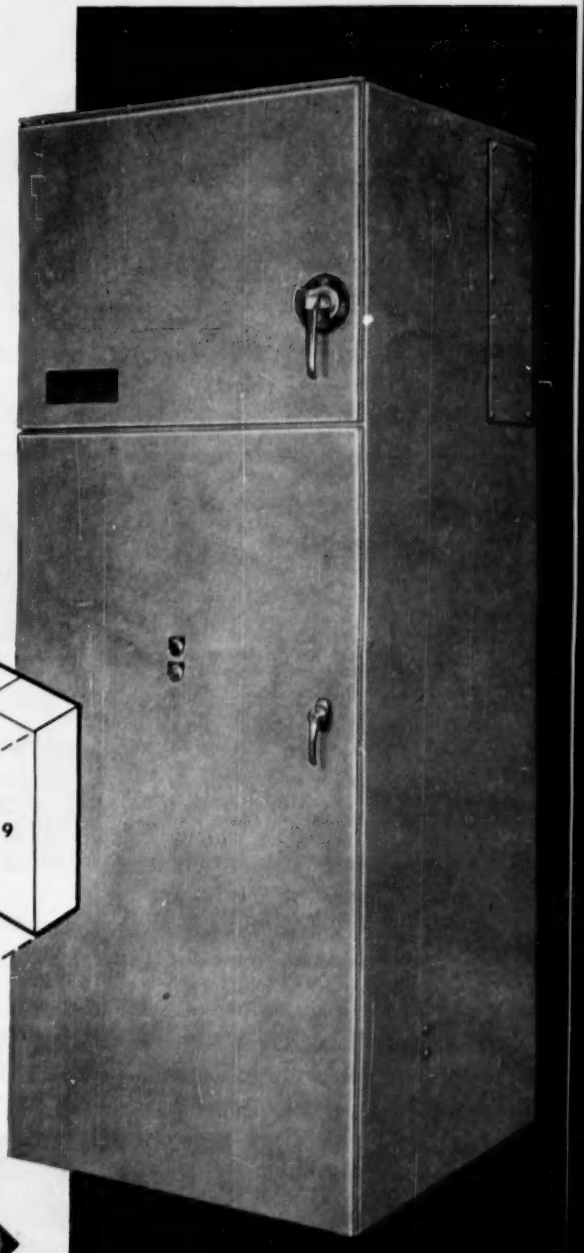
Smaller size is only one of many advantages in this new Allis-Chalmers design. You also get full-front access, more room for optional features, a completely tested unit, and the ultimate in protection for men and machines.

For more information on how this new control design can help you, call your nearest Allis-Chalmers representative, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

9 competitive units in a line require 342 inches.



You get an extra unit in less space with Allis-Chalmers. *10* Allis-Chalmers units require only 340 inches.



ALLIS-CHALMERS

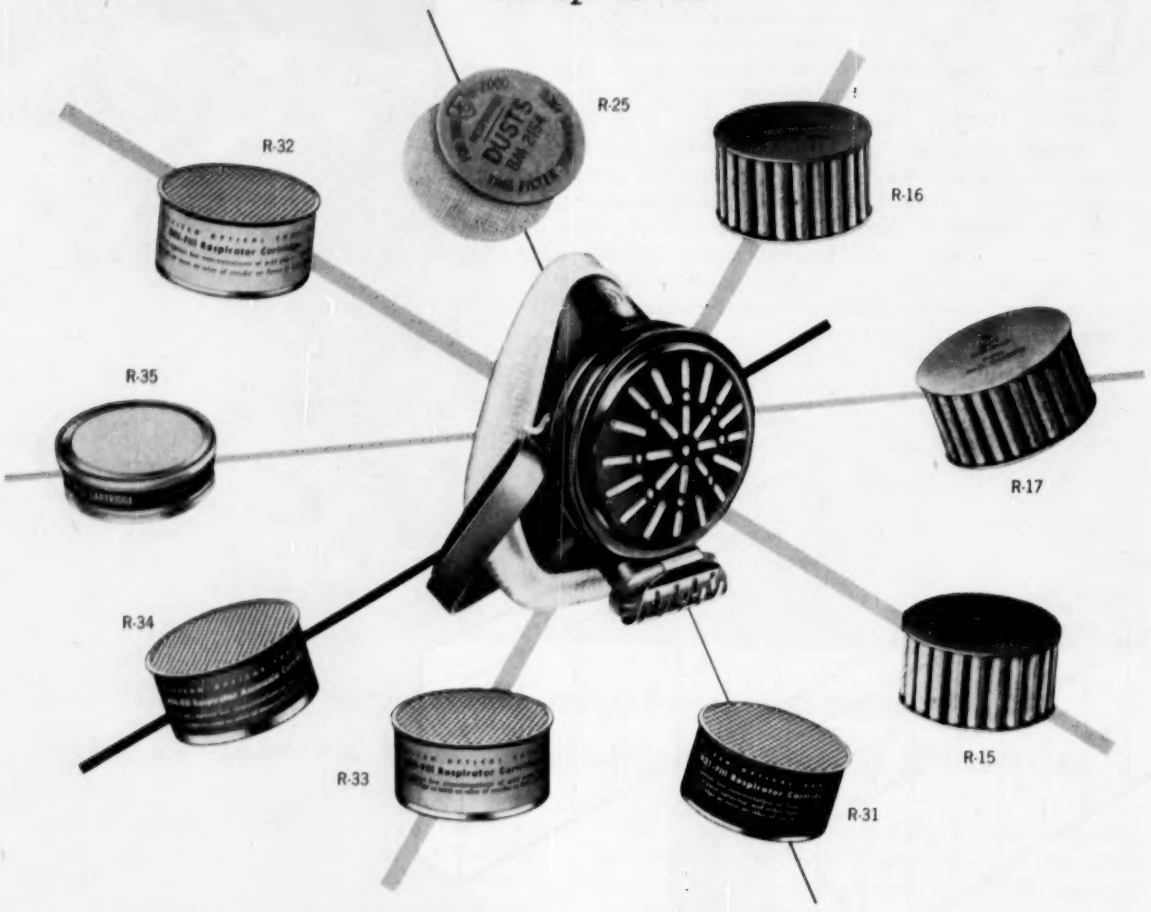
A-5518

~~8~~ in 1

AO Respirators

Now...9 in 1!

Inventory Saving, Cost Saving AO R-2000 Series Respirator



Yes, with the addition of the NEW R-35* Cartridge (and other cartridges and filters), the AO R-2000 can be quickly converted to one of nine respirators for protection against a multitude of dust, gas and vapor hazards — singly or in combination.

*Recommended for exposures to low concentrations of All Dusts not significantly more toxic than lead and Organic Vapors simultaneously.

Your nearest American Optical Safety Products Representative can supply you. Always insist on AO trademarked safety products.

American Optical Company
SAFETY PRODUCTS DIVISION

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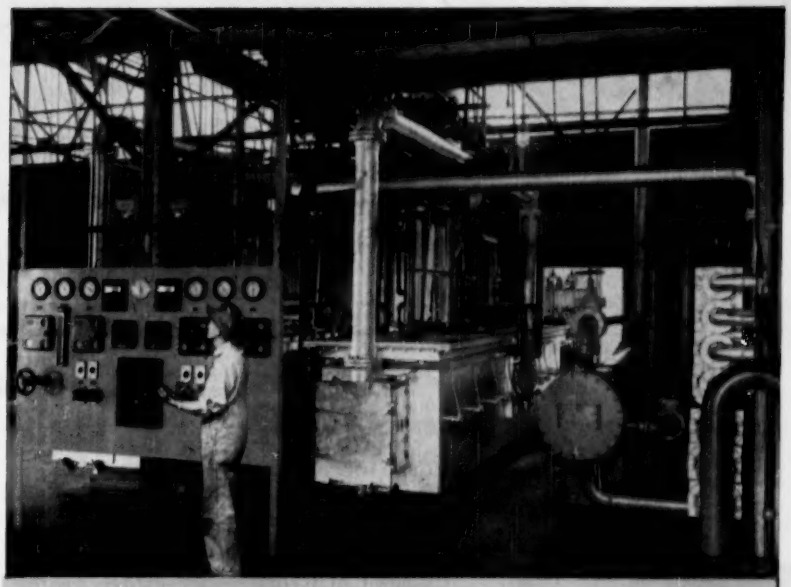
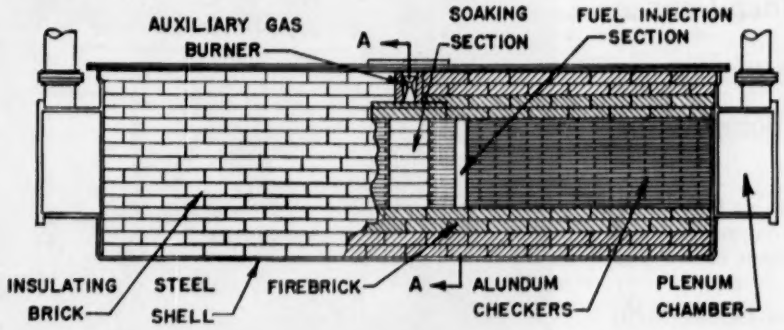
Branches in Principal Cities

ALUNDUM* checkers give 4 years continuous service



In this double regenerative furnace the Wulff Process Company of Huntington Park, Calif., produces acetylene starting with propane or other petroleum gas as the raw material. The Wulff Company reports that ALUNDUM checkers in this equipment are still going strong after continuous service, five days a week for more than four years.

Wulff Process Company says no replacement required in acetylene producing furnaces



Cross sectional diagram shows, in yellow, the location of Norton ALUNDUM checkers in the Wulff furnace. Air, preheated in the first ALUNDUM regenerator to 1800° F., is mixed with gas in the fuel injection section producing high temperatures and transferring this heat to the second regenerator. A propane-steam mixture is then passed in the opposite direction through the regenerators, heating and cracking in the second and cooling in the first. The heating and cracking cycles are both of one minute duration. ALUNDUM checkers take this extreme cyclic thermal stress and provide efficient, low cost operation.

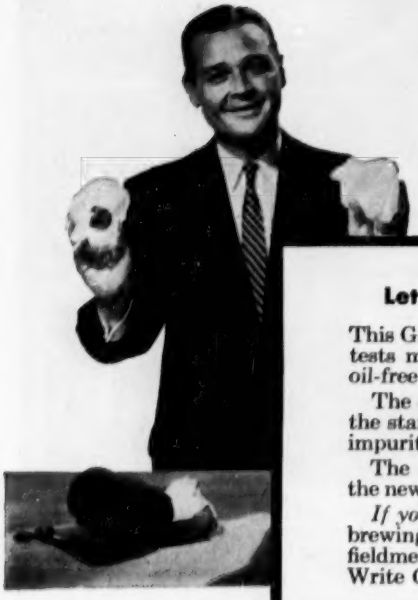
Tubular passages for preheated flow are formed by ALUNDUM checkers. Their resistance to the erosion of hot gases is extremely important in many installations. Also, their purity is essential. Iron or other impurities could result in harmful side reactions in such gas cracking operations.

Norton refractories, engineered and prescribed for better performance in many types of equipment, provide long life, exceptional hot strength and maximum protection against the mechanical and chemical attacks of a wide variety of fuels. For further facts on these advantages write to NORTON COMPANY, Refractories Division, 512 New Bond St., Worcester 6, Mass.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed
Making better products... to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Grinding Machines • Refractories
BEHR-MANNING DIVISION PRODUCTS: Coated Abrasives • Sharpening Stones • Behr-cut Tapes



Is the oil-free air you use really oil-free?

Let us make this sterile cotton test on your air compressors

This Gardner-Denver fieldman is showing you the results of two air discharge tests made on two air compressors—one of them the *new* Gardner-Denver oil-free Model CACB.

The cotton filter on your left, upon removal from the air discharge pipe of the standard compressor, showed discolorations made by oil stains and other impurities.

The cotton filter on your right was removed from the discharge pipe of the new CACB compressor—*entirely free from oil vapor and other foreign matter.*

If you must have pure, oil-free air for instrument controls, food processing, brewing, distilling, or the manufacture of plastics and other products, our fieldmen will come on call to test your compressors for oil contamination. Write Gardner-Denver Company, Quincy, Illinois.

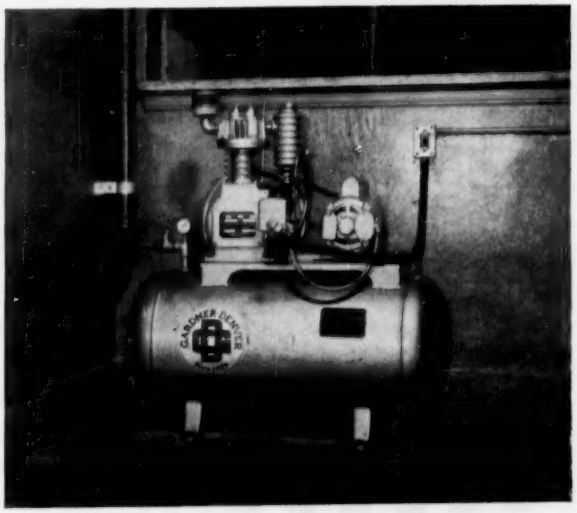
It's oil-free . . . if it's from the *new* CACB!

Another Gardner-Denver "First"—oil-free air from a small compressor

Now, for the first time, oil-free air is available from a small, space-saving compressor—base or tank mounted—for instrument control and other small-capacity uses.

The heart of the new Gardner-Denver CACB oil-free compressor is the carbon parts which require no oil or water lubrication in the cylinder.

The CACB is a single-stage, air-cooled compressor that supplies 4 to 5 cubic feet of oil-free air per minute. It is suitable for discharge pressures of 40 to 100 psi. Automatic start and stop controls are supplied as needed. In addition, it has the same quality construction features of all Gardner-Denver tank-mounted compressors; for example, an alloy crankshaft with self-lubricating main bearings on *both sides* of the throw.



Write for complete details.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

DU PONT
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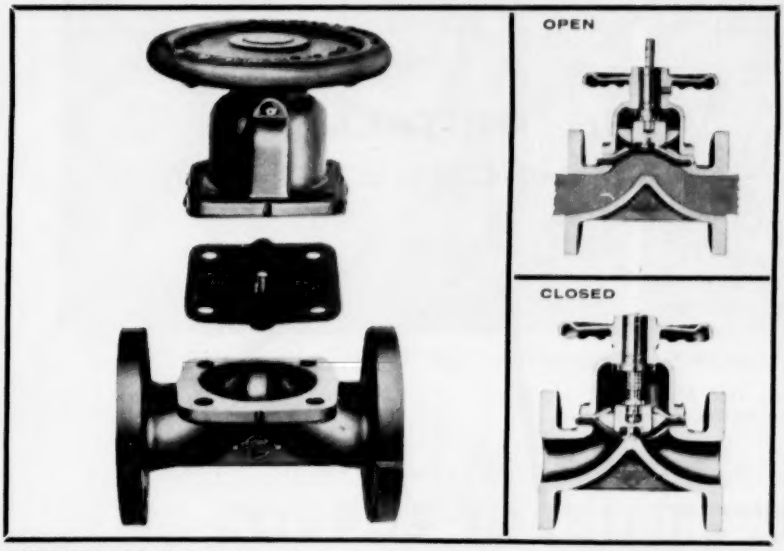
NEWS

No leakage of concentrated H_2SO_4 in more than a year with valve diaphragms made of Du Pont TEFLON®
tetrafluoroethylene resins



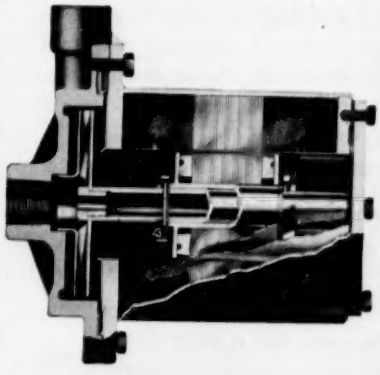
DIAPHRAGMS of Du Pont TEFLON resins used in chemical valves are tough and flexible, unaffected by corrosives and heat. Because of line pressures and required flexibility, 350°F. is maximum recommended temperature for this valve. (Diaphragms fabricated by the Joclin Manufacturing Company, Wallingford, Conn., for the Grinnell Company of Providence, R. I.)

Where previous types of valves showed leakage in three weeks, Grinnell-Saunders chemical valves using diaphragms made of TEFLON tetrafluoroethylene resins are still in service after a year. Owing to the use of these resins, they are successfully handling sulfuric acid in 85% concentration at outdoor temperatures and standard pressure.

The excellent flex strength of parts made of TEFLON resins is illustrated in this application. The diaphragm is subjected to a flexing process which turns it "inside-out" along a circular line of stress. When thin-walled components such as this diaphragm are made of TEFLON resins, they are tough, pliable, long-lasting. TEFLON tetrafluoroethylene resins have practically universal chemical inertness. They are unaffected by temperatures up to 500°F. and can be manufactured in complex, accurate shapes with tolerances to half a mil. The "waxy" surface of the diaphragm has no tendency to stick to the metal seat after closure.

Great improvements in service life are made possible by the use of TEFLON resins. For example, the same valves have been successfully employed in such difficult applications as control of (1) an $AlCl_3$ complex at ambients to 220°F. at 0-50 psi; (2) benzene hexachloride with free chlorine at 120-130°F., 10 to 20 psi; (3) 90-95% nitric acid plus 1.8% hydrofluoric acid at outdoor temperatures and 125 psi.

Learn how the properties of TEFLON resins can help you solve problems in handling and processing. Send the coupon for more details.



PARTS MADE OF TEFLON tetrafluoroethylene resins are used in Series-S Chempumps for leakproof pumping of corrosive, toxic, noxious, volatile, hot and radioactive liquids. The design employs a "canned" electric motor and eliminates shaft seals and stuffing boxes. TEFLON resins are used for jacketing the stainless-steel gaskets that seal the pump housings. The thrust bearings in the pump can be made of reinforced TEFLON resins. Bearings made of TEFLON resins need no external lubrication due to very low surface friction . . . eliminate contamination of pumpage by lubricants. (Made by Chempump Corp., Philadelphia, Pa.)

TEFLON®
is a registered trademark . . .

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the tetrafluoroethylene resins discussed herein. This registered trademark should not be used as an adjective to describe any product, nor should it be used in whole, or in part, as a trademark for a product of another concern.

SEND FOR INFORMATION

For additional property and application data on Du Pont TEFLON tetrafluoroethylene resins, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 712, Du Pont Building, Wilmington 98, Delaware

Please send me more information on Du Pont TEFLON tetrafluoroethylene resins. I am interested in evaluating this material for _____

Name _____

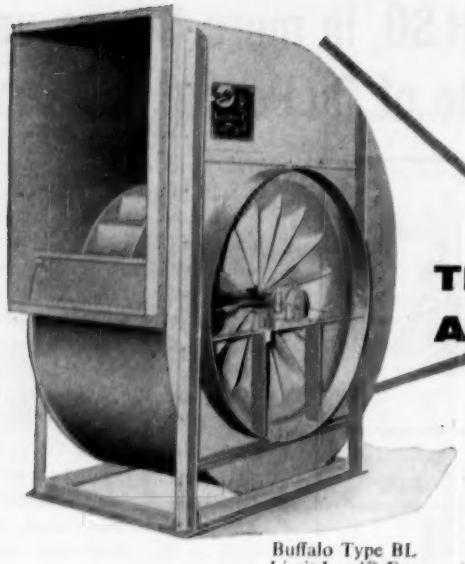
Company _____ *Position* _____

Street _____

City _____ *State* _____

Type of Business _____

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec



Buffalo Type BL
Limit-Load® Fan

THE "INSTALL-IT AND-FORGET-IT-FAN"

FOR INDUSTRIAL AIR-MOVING

With the "Buffalo" Type "BL" Fan, you're assured of dependable, economical, long lasting air-moving service for **your** particular air conditioning, ventilating or other industrial application. Here's why:

LONG, TROUBLE-FREE LIFE: because "Buffalo" gives you heavy gauge construction, rigid bracing, oversize self-aligning bearings, and a wheel which is die stamped, riveted and welded.

FULL RATED DELIVERY ON THE JOB: is insured by the proven backward-curved blade wheel, die-formed fixed inlet vanes, and wheel-suited housing.

QUIET OPERATION: made possible by complete streamlining from inlet to outlet plus precision balance of the wheel.

EASY INSTALLATION: on sturdy base, due to ample inlet and outlet collars. Larger sizes have split housings for convenient handling during installations.

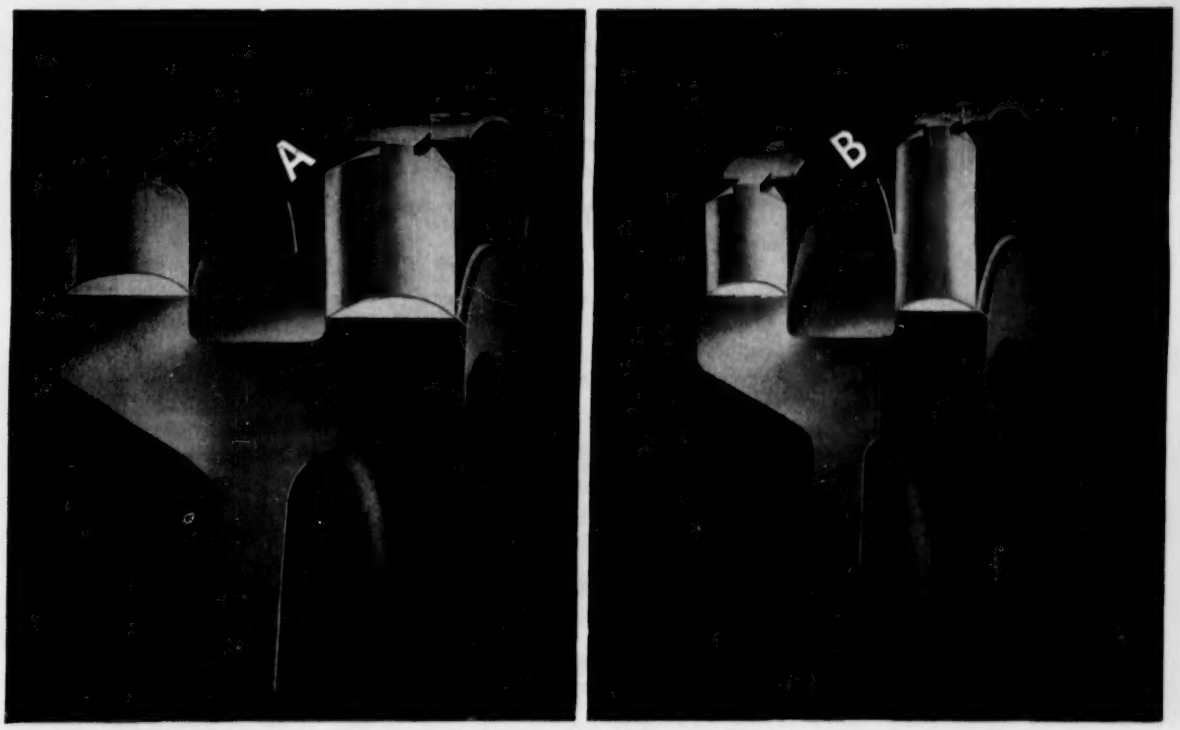
Every "Buffalo" Fan is test-run before it leaves our shop. This assures you of peak efficiency . . . smooth, quiet operation . . . and a long life of completely reliable service. Want Full Details on "Buffalo" Type "BL" Fans? Just write us, now, for Bulletin F-102.

. . . that is, forget your "Buffalo" Type "BL" Fan as far as any day-to-day attention is concerned. It'll do its superb job, month-after-month, year-after-year, with no servicing other than routine maintenance. You can rely on the famous "Buffalo" "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

BUFFALO FORGE COMPANY
BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



(Left, A) wide bucket "L" type wheel. (Right, B) regular type wheel for Coppus Steam Turbines

Now...for low steam consumption – **COPPUS TURBINES** *can be furnished with wide bucket "L" type wheel*

Good news for steam turbine users where low steam consumption is important!

The Coppus Type "L" Wheel is the answer to this problem. Larger turbine buckets are employed to make the most economical use of steam.

In every respect the Coppus Turbine offers the top-quality features and advantages that have made the Coppus line outstanding for efficiency and economy. For example:

- Turbines rated close to your exact hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther.* Send for Bulletin 135 on Coppus Turbine.

COPPUS ENGINEERING CORPORATION
232 Park Avenue
Worcester 2, Mass.
Sales offices in
THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

RARE EARTH RESEARCH

Recent interesting rare earth research developments

a report by LINDSAY

We are frequently fascinated by the imagination of researchers who are working with the rare earths. It appears that technical people, observing the many essential uses of rare earth salts in chemical and industrial processes, are looking at these fifteen unique elements as a fertile field for exploration.

During recent years, rare earths have been accepted as basic chemical tools in a wide cross section of American industry. This suggests that fruitful results may be expected from the rare earth research projects currently being carried on in industrial laboratories and pilot plant operations from coast to coast. Here, for instance, are half a dozen which may interest you.

MILES OF MISCH. This isn't a new application, but we're wondering if you know that misch metal (an alloy of the mixed rare earths) is available in wire form as well as in ingot and rod form? Cerium alloys can also be had in powder form; they are used as getters in vacuum tubes. We don't make the metal, but we can put you in touch with those who do.

FLAME SPRAYING. A new process for flame spraying various refractory oxides on metallic surfaces has been brought to near completion. Titania, zirconia and alumina can be flame sprayed, but the thing that interests us is that flame sprayed cerium oxide has some unusual properties. Rare earth oxide is a good heat radiation material, and it seems that metallic surfaces coated with rare earth oxide radiate heat much faster than do untreated surfaces.

RARE EARTHS IN PLASTICS. We frankly don't know what sort of things rare earth-impregnated plastics could be used for, but a couple of people have taken enough interest in this problem to make up experimental samples. We've been doing some playing with them ourselves and have some ideas about using them. Polyethylene, for example, can be fabricated to hold up to 5 to 10 times its weight of rare earth oxide, and we've even seen some precision-bore epoxy tubing made with a rare earth oxide filler.

SEPARATION AND SAMARIUM. We are like a slaughter house in that we would like to use everything that a rare earth separation process turns out, including the squeal. With the interest that has been generated in using gadolinium as a neutron absorber (thermal cross section about 46,000 barns), we have accumulated quite a pile of samarium oxide in rather decent purity. In the process of separating gadolinium and some of the other rare earths, samarium is produced as a by-product. If you can think of a use for samarium, we have the samarium compounds.

RARE EARTH GARNETS. These are structurally somewhat similar to the garnet variety grossularite (formula $Ca_3Al_2(SiO_4)_3$). The most interesting ones are the rare earth-iron garnets such as $Y_3Fe_2(FeO_4)_3$. This mouthful of formula has been abbreviated by researchers to "YIG" for obvious reasons. Other names stem from other rare-earth symbols. These garnets, particularly those of yttrium, gadolinium, erbium, and some others have interesting ferromagnetic properties, making them useful as ferrite materials in electronic equipment. We don't make the garnets, but we do make the rare earth oxides needed to prepare them.

SINTERED SHAPES. One of our friends once wanted to know if rare earth oxides could be pressed and sintered into shaped pieces. Apparently they can, and our friend made up some experimental hot-pressed rare earth oxide and cerium oxide pieces for us.

Lindsay produces thorium and rare earth salts in purities up to 99.99% for a rather surprising variety of chemical and industrial applications. Most of these materials are available for prompt shipment in quantities from a gram to a carload.

We will be pleased to supply your research and process development people with technical data, analyses, prices and whatever may be helpful to you in exploring the possibility of the profitable application of rare earths to your own problems.

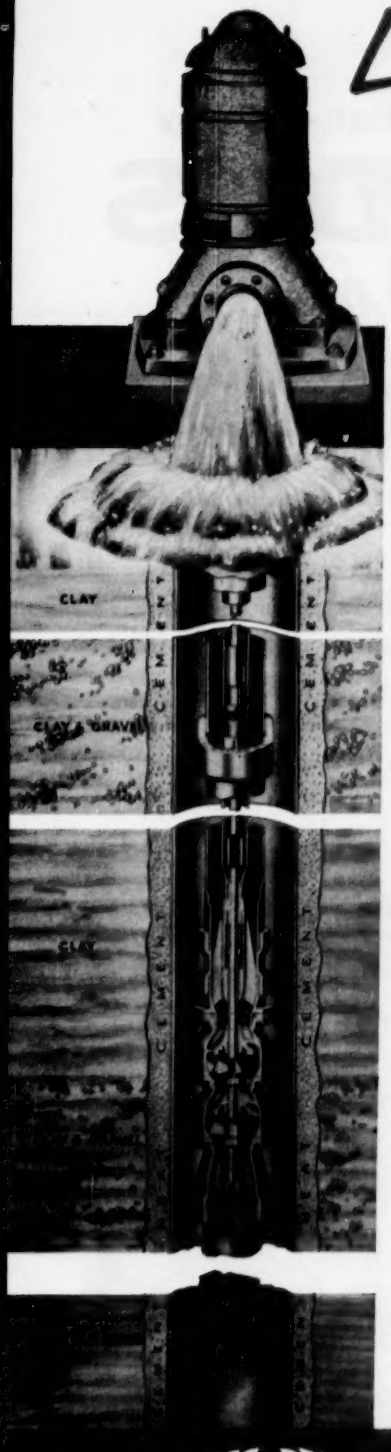
PLEASE ADDRESS INQUIRIES TO:

LINDSAY CHEMICAL COMPANY

World's Largest Producer of Thorium and Rare Earth Chemicals

286 ANN STREET • WEST CHICAGO, ILLINOIS

Layne knows more about water bearing formations!



On whose say-so? Not on ours—but on the experience of scores of American and foreign firms and municipalities whose very existence and success depend on an adequate supply of water.

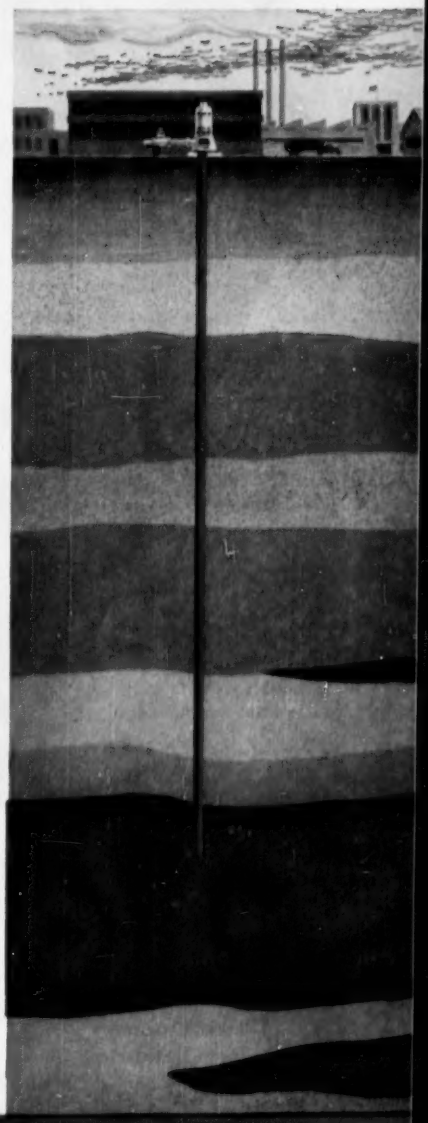
Knowing where the water is—and then tapping the subterranean source is but a part of the vast knowledge the Layne organizations have accumulated in three quarters of a century.

Once the source is determined and the water supply developed, a dependable means for delivering the water must be provided, and that's where the famous Layne pump comes in. For each Layne pump is specifically engineered for the particular job. There is no "stock" Layne pump. Your pump is created for your job—making use of the knowledge of strata, water requirements and usage.

ENGINEERED, DEPENDABLE PERFORMANCE IS WHAT YOU GET WHEN LAYNE DOES THE JOB—COMPLETE FROM WATER LOCATION TO YEAR AFTER YEAR OF TROUBLE-FREE PUMPING.

YOUR NEXT WELL AND PUMP INSTALLATION MAY BE MONTHS OFF. GET TO KNOW THE LAYNE FOLKS IN YOUR AREA. SAVE TIME AND MONEY THROUGH THEIR INTIMATE KNOWLEDGE OF WATER.

Send now for our general services bulletin No. 100.



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75 YEARS OF PROGRESS

WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

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LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

HARSHAW

Production-Controlled High-Quality

FLUORIDES

Boron Trifluoride
Hydrofluoric Acid

ANHYDROUS . . . AQUEOUS

The uses for Fluorides are ever increasing. Harshaw Fluoride production also has increased steadily. Shipments of cylinders, tank trucks and tank cars leave our plant daily. If required, you are invited to draw on the knowledge and experience of our staff of technical specialists on Fluorides.

Write for your free copy of M.C.A. Chemical Safety Data Sheet SD-25 on properties and essential information about . . .
HYDROFLUORIC ACID
Anhydrous and Aqueous

THE HARSHAW CHEMICAL CO.
1945 EAST 97th STREET • CLEVELAND 6, OHIO
Chicago • Cincinnati • Cleveland • Detroit
Hastings-On-Hudson, N.Y. • Houston
Los Angeles • Philadelphia • Pittsburgh

Here is a helpful list of HARSHAW production-controlled high-quality fluorides:

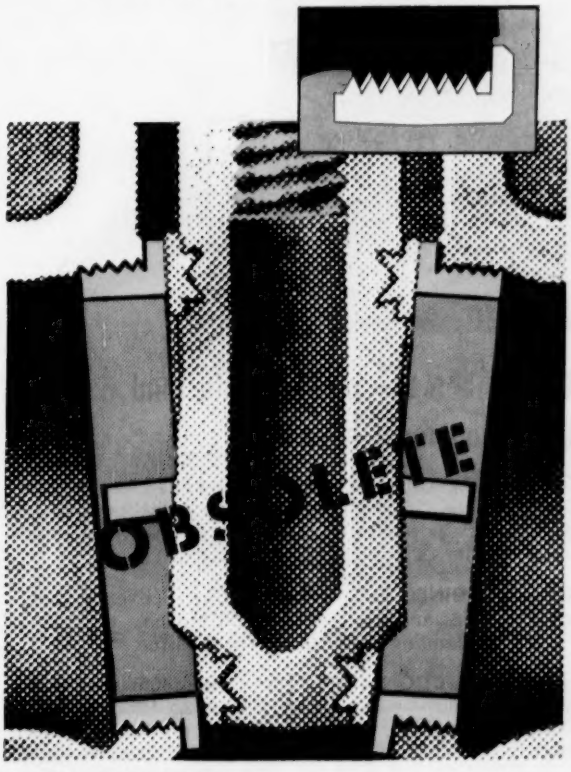
Ammonium Bifluoride
Ammonium Fluoborate
Antimony Trifluoride Sublimed
Barium Fluoride
Bismuth Fluoride
Boron Trifluoride
Boron Trifluoride Complexes
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorine Cells
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid Anhydrous
Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
Lead Fluoborate
Metallic Fluoborates
Potassium Bifluoride
Potassium Chromium Fluoride
Potassium Fluoborate
Potassium Fluoride
Potassium Titanium Fluoride
Silico Fluorides
Sodium Fluoborate
Tin Fluoborate
Zinc Fluoborate
Zinc Fluoride

ARE YOUR TRIM SPECS UP TO DATE?

Put an end to iron valve seat ring and stem-wedge problems. Make sure your specifications call for modern, trouble-free OIC end-seated seat rings and T-head stems.

There is no extra cost and yet this superior design will reduce your maintenance overhead many times.

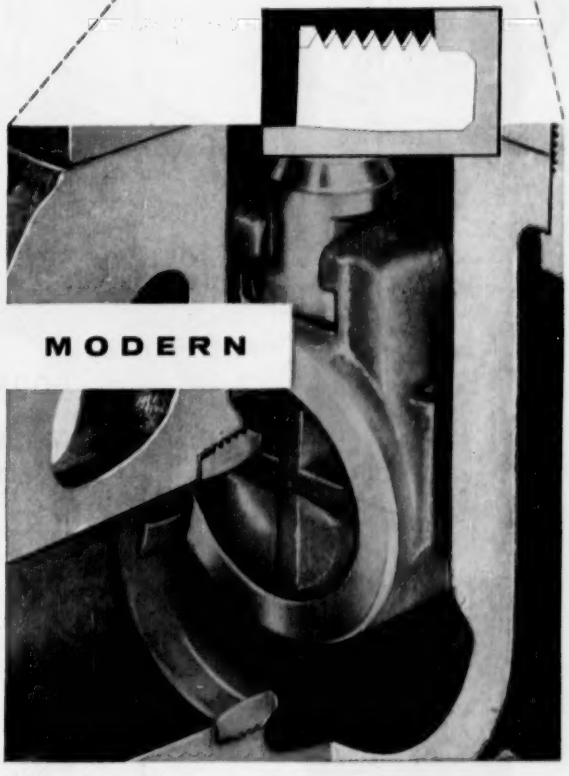
For specification details write for OIC Iron Valve Bulletin No. 1005. The Ohio Injector Co., Wadsworth, Ohio.



Shoulder-seated rings
Screwed stem-wedge connection

Ring design causes turbulence. Open back of ring is easily eroded. Ring is seated in tension. Continuous operation compresses and tends to loosen it, developing serious leaks.

A screwed stem-wedge connection is rigid. Closing valve under pressure tends to bind wedge, make closing difficult and perhaps bend the stem.



OIC end-seated rings
T-head, stem-wedge connection

Streamlined flow-through. No pockets open to attack by erosion. Ring is seated in compression. Stays tight even in continuous operation.

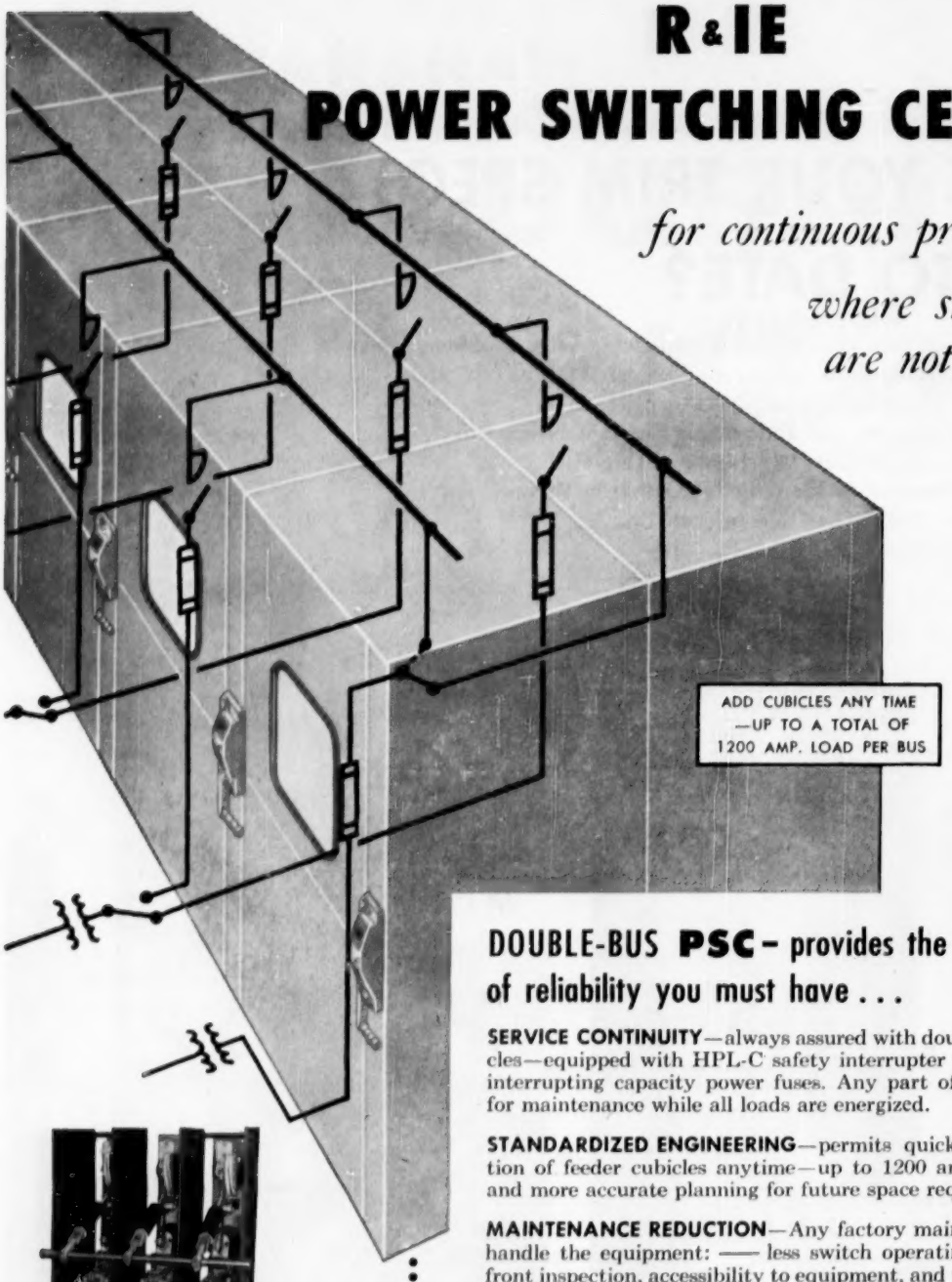
T-head stem-wedge connection is flexible. Wedge can't bind. Closing is easy and stem is unaffected.

OIC VALVES | FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

R&IE
POWER SWITCHING CENTERS

for continuous processing—

where shut-downs are not tolerated



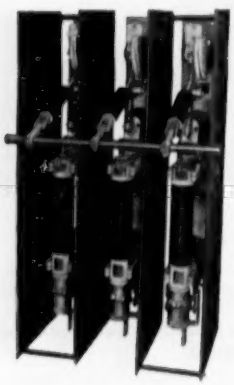
DOUBLE-BUS **PSC**- provides the kind of reliability you must have . . .

SERVICE CONTINUITY—always assured with double-bus PSC cubicles—equipped with HPL-C safety interrupter switches and high interrupting capacity power fuses. Any part of system available for maintenance while all loads are energized.

STANDARDIZED ENGINEERING—permits quick deliveries; addition of feeder cubicles anytime—up to 1200 amperes total load; and more accurate planning for future space requirements.

MAINTENANCE REDUCTION—Any factory maintenance crew can handle the equipment: —— less switch operating effort; window front inspection, accessibility to equipment, and universally known power fuses.

Ask your I-T-E Representative to show you the many economies of PSC cubicles—and the optional TOG-L SNAP switch operating mechanism, for added safety in closing in against faults.



FUSED HPL-C INTERRUPTERS
Ratings—up to 14.4 Kv (110 BIL)
600 Amperes
(40,000 Amps. momentary)
1200 Amperes
(60,000 Amps. momentary)

R&IE

R & IE EQUIPMENT DIVISION
I-T-E CIRCUIT BREAKER CO.
GREENSBURG, PA.

PSC-5

You get *personalized container service* from

USS

Your US Steel representative makes it his business to understand yours, so he can help you select the right container for your needs. Profit from this know-how and personal service next time you shop for containers. Your US Steel salesman is always as near as your telephone.

Profit from all 5 of these US Steel extras, too.

- **Best rust protection**—there's more zinc phosphate on every USS rust-inhibited container.
- **Eye-catching containers**—your containers not only ship your product, but advertise it, too—when color-decorated by U. S. Steel.
- **Prompt container delivery**—a 7-point factory system gives you next-door service anywhere—any time.
- **Widest container variety**—from 2½-gallon pails to 55-gallon drums, including stainless.
- **Lower unit cost**—USS stainless-steel containers with their patented design give lifetime service at unequaled long-run economy.

UNITED STATES STEEL PRODUCTS

DIVISION

UNITED STATES STEEL CORPORATION

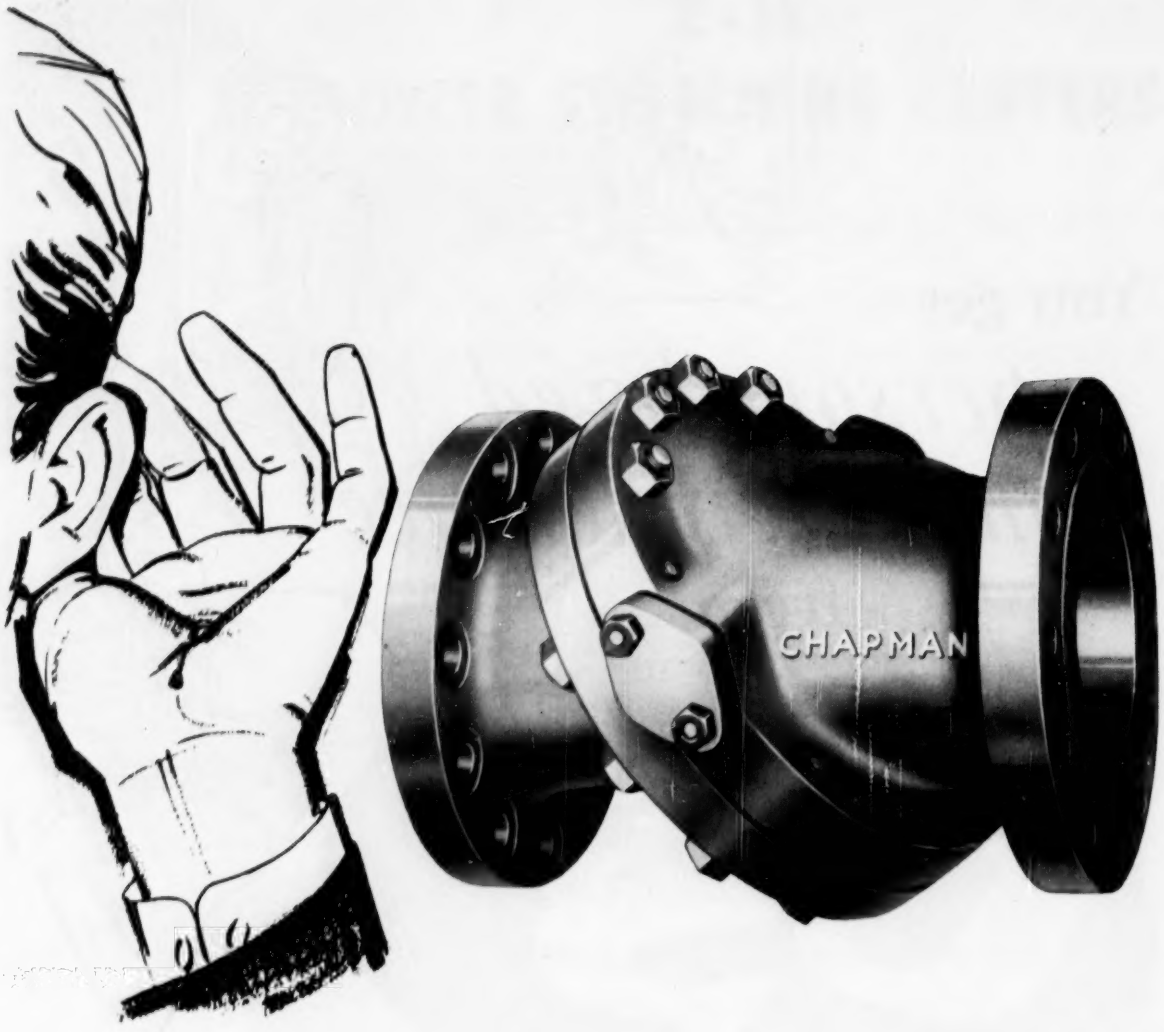
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Los Angeles and Alameda, Calif. • Port Arthur, Texas
Chicago, Ill. • New Orleans, La. • Sharon, Pa. • Camden, N. J.

USS STEEL DRUMS

USS

UNITED STATES STEEL



With Valves . . . there's nothing like the silent treatment!

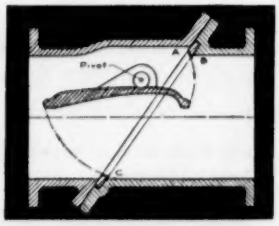
CHAPMAN Tilting Disc Check Valves

Add it all up. With Chapman Tilting Disc Check Valves you get no flutter, no vibration, no slamming or jarring or scraping of disc and seat. You get fast, sure and *quiet* operation at all times.

This is the silent treatment for valves and what it means to you is a matter of dollars and cents. You have less headaches, less trouble, less maintenance for valves and system even under severe operating conditions.

This silent treatment is an exclusive with Chapman Tilting Disc Check Valves in iron and steel . . . has been for years. These quick and quiet valves handle fluids or gases under a wide range of pressures.

You can order them for replacement or new systems. Why not, right now, check our Catalog 30-A? If you don't have a copy readily on hand, write for it today.

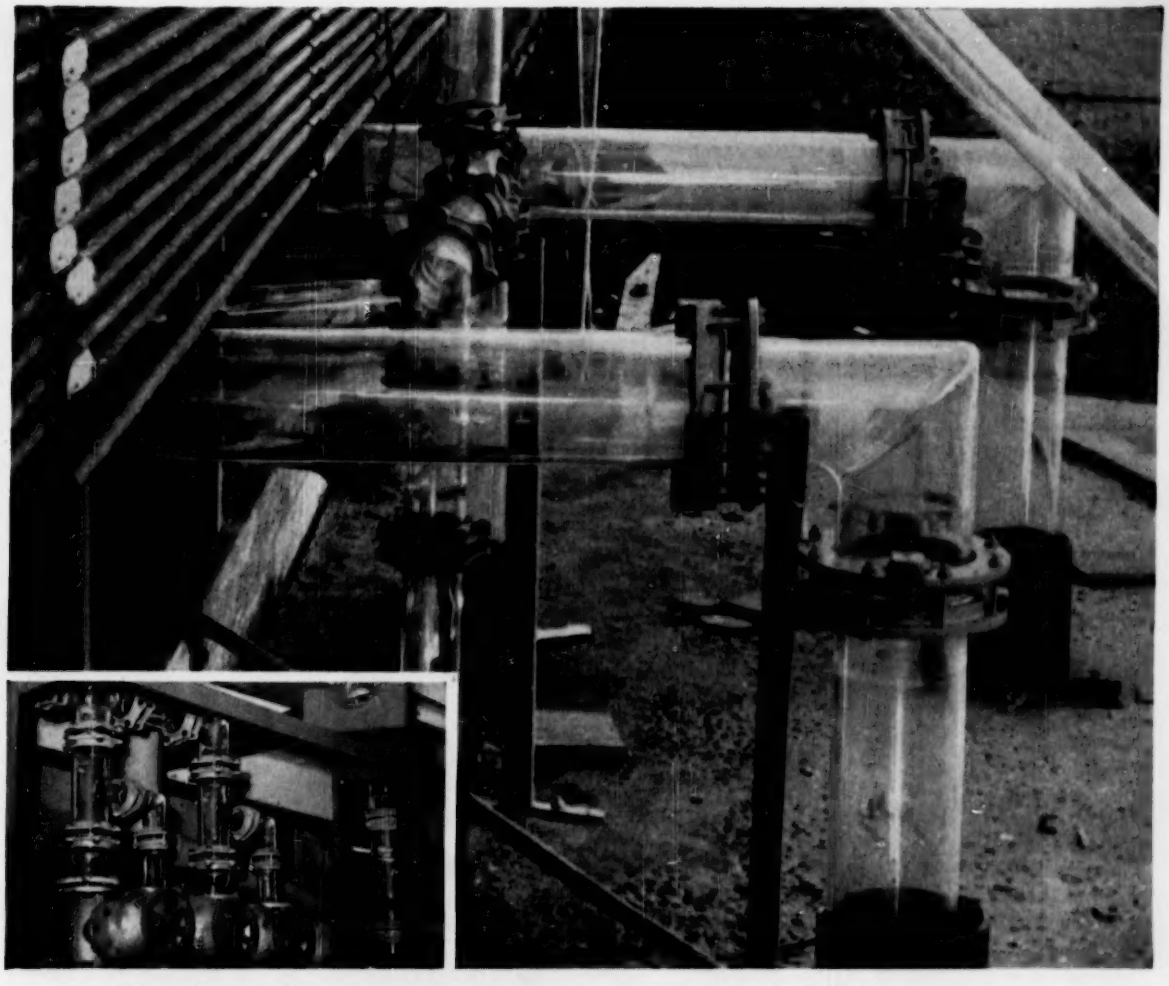


Here's the Inside Story

When the flow is on, "airfoil disc," supported on pivot, floats on whatever flow there is. When the flow stops, disc drops quickly, quietly and firmly on special bevel seat. You'll note that there is sufficient space around disc to cut down flow resistance.

THE CHAPMAN VALVE MANUFACTURING CO.

INDIAN ORCHARD, MASSACHUSETTS



Chemical Mixing Manifold

Outside Vapor Lines

How glass pipe solves a mile-long corrosion problem

Champion Paper & Fibre Co., at its Canton, N. C. plant, was faced with a big corrosion problem . . . almost a mile long.

They are solving it with PYREX brand "Double-Tough" glass pipelines ranging in size from one to six inches in diameter . . . four thousand feet of it in 1955, more in 1956.

And it's really tough corrosion service — handling chlorine dioxide vapor and liquid solutions.

The chlorine dioxide is made by mixing sulphuric acid, sodium chlorate and sulphur dioxide. Residual acid is generally present, and recent developments indicate better quality chlorine dioxide is obtained by adding salt which could give a hydrochloric acid by-product.

Ease of handling and maintenance are also factors with Champion Paper. All of the pipe was installed by the company's own pipe fitters and welders.

If you have a problem involving corrosion in your plant—whether it's a five-foot drainline or a mile-long pipeline—call on your distributor of PYREX brand pipe. He'll be glad to help you. Write for his name and for more detailed information.

CORNING GLASS WORKS
112 Crystal Street, Corning, N. Y.

Please send me more detailed information on PYREX brand "Double-Tough" glass pipe ☐; send name of nearest PYREX pipe distributor ☐.

Name..... Title.....

Company.....

Street.....

City.....

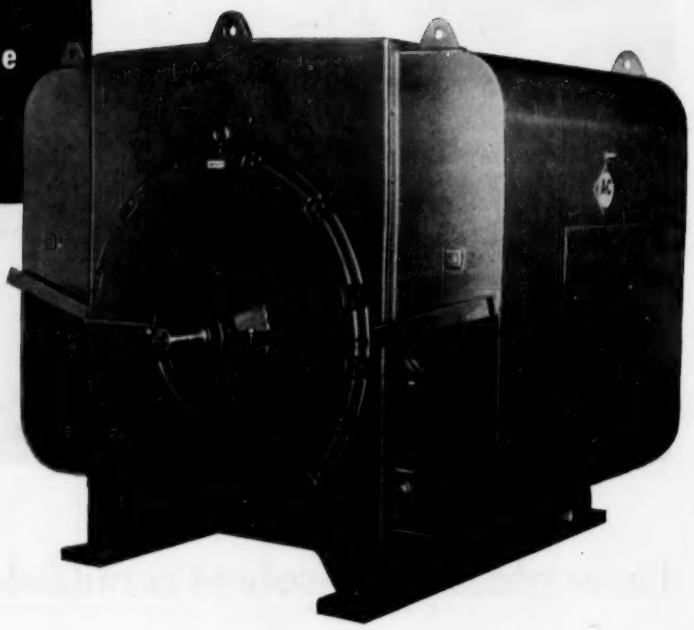
Zone..... State.....

Corning means research in Glass

CORNING GLASS WORKS, 112 Crystal Street, Corning, N. Y.

Eliminate costly enclosures with Allis-Chalmers weather-protected MOTORS

Modern features
cut operating, maintenance expense . . . give MORE dependability



Here's a newly designed line of Allis-Chalmers weather-protected motors with the ability to "take" outdoor conditions. This means no expensive protective enclosures are needed . . . a big saving in plant or installation building costs.

Designed to meet defined NEMA requirements, these motors incorporate many important features which assure dependable outdoor operation:

- **Ventilating System** — Low velocity intake, vertical lift, change of direction and high velocity discharge of ventilating air keep rain, snow, sleet, dust and dirt out of vital parts.
- **Removable Air Ducts** — To facilitate inspection and maintenance of interior air passages, air intake ducts are designed for quick removal.
- **Stator Assembly** — Removable as a unit, it simplifies maintenance and minimizes downtime.
- **Split Sleeve Bearings** — Capsulized design permits access to motor interior without disturbing the bearings or their enclosures. Positive vapor seal is used on high-speed motors. Antifriction bearings are available for slow speed motors.
- **Proven Insulation** — Famous Allis-Chalmers insulation systems (Class A and B) are available. And, for extreme temperatures, or where high resistancé to abrasion and moisture is required, Allis-Chalmers can provide the revolutionary *Silco-Flex* system.

Silco-Flex is an Allis-Chalmers trademark.

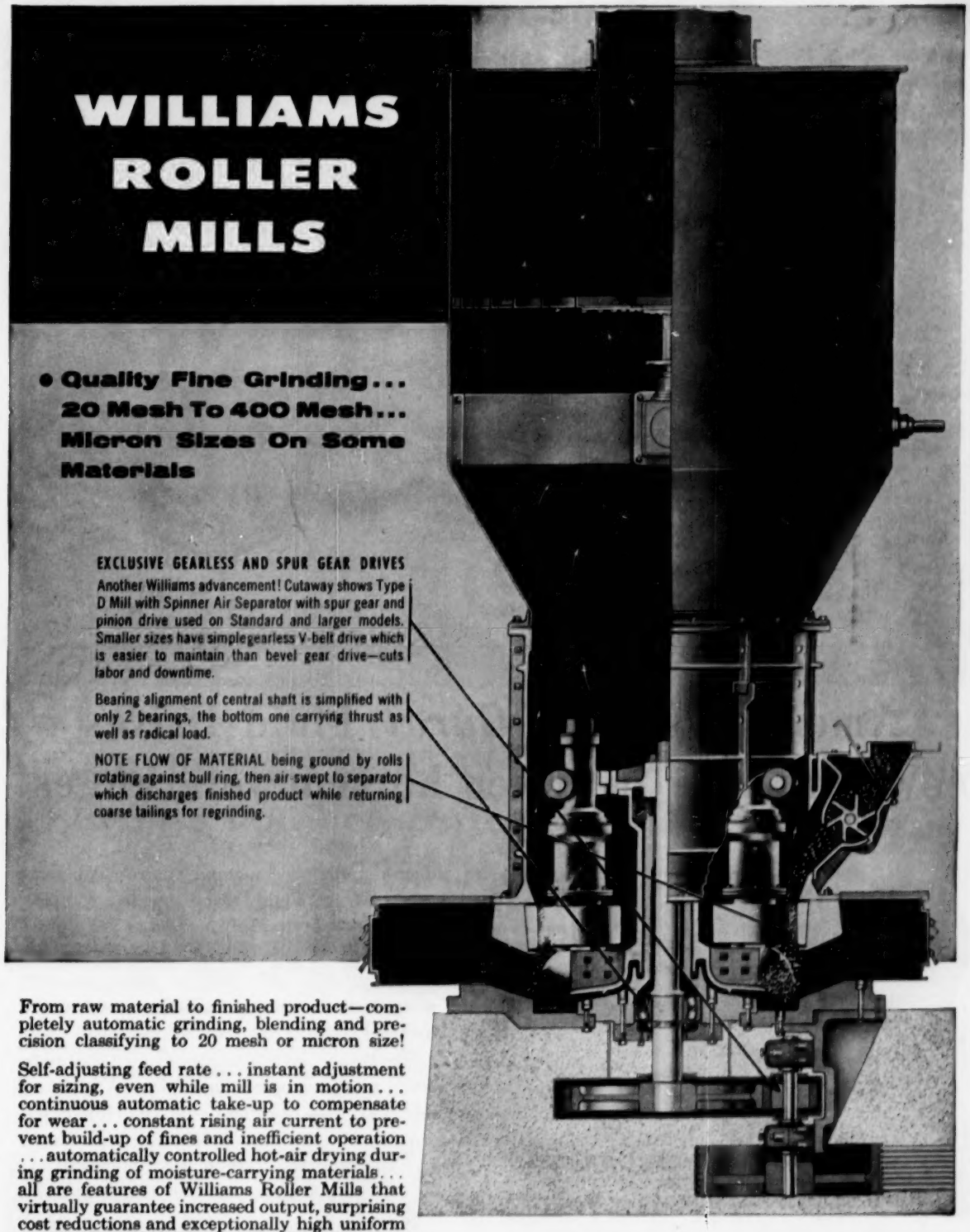
THIS DESIGN available in ratings from 250 to 900 hp. Other designs in larger horsepower ratings are also available. Contact your A-C sales office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. Ask for Bulletins 51B8606A and 05B7894.

A-5292

ALLIS-CHALMERS

WILLIAMS ROLLER MILLS

• Quality Fine Grinding... 20 Mesh To 400 Mesh... Micron Sizes On Some Materials



EXCLUSIVE GEARLESS AND SPUR GEAR DRIVES

Another Williams advancement! Cutaway shows Type D Mill with Spinner Air Separator with spur gear and pinion drive used on Standard and larger models. Smaller sizes have simple gearless V-belt drive which is easier to maintain than bevel gear drive—cuts labor and downtime.

Bearing alignment of central shaft is simplified with only 2 bearings, the bottom one carrying thrust as well as radical load.

NOTE FLOW OF MATERIAL being ground by rolls rotating against bull ring, then air-swept to separator which discharges finished product while returning coarse tailings for regrinding.

From raw material to finished product—completely automatic grinding, blending and precision classifying to 20 mesh or micron size!

Self-adjusting feed rate . . . instant adjustment for sizing, even while mill is in motion . . . continuous automatic take-up to compensate for wear . . . constant rising air current to prevent build-up of fines and inefficient operation . . . automatically controlled hot-air drying during grinding of moisture-carrying materials . . . all are features of Williams Roller Mills that virtually guarantee increased output, surprising cost reductions and exceptionally high uniform quality. Get all the facts immediately . . . *Write today for catalog.*

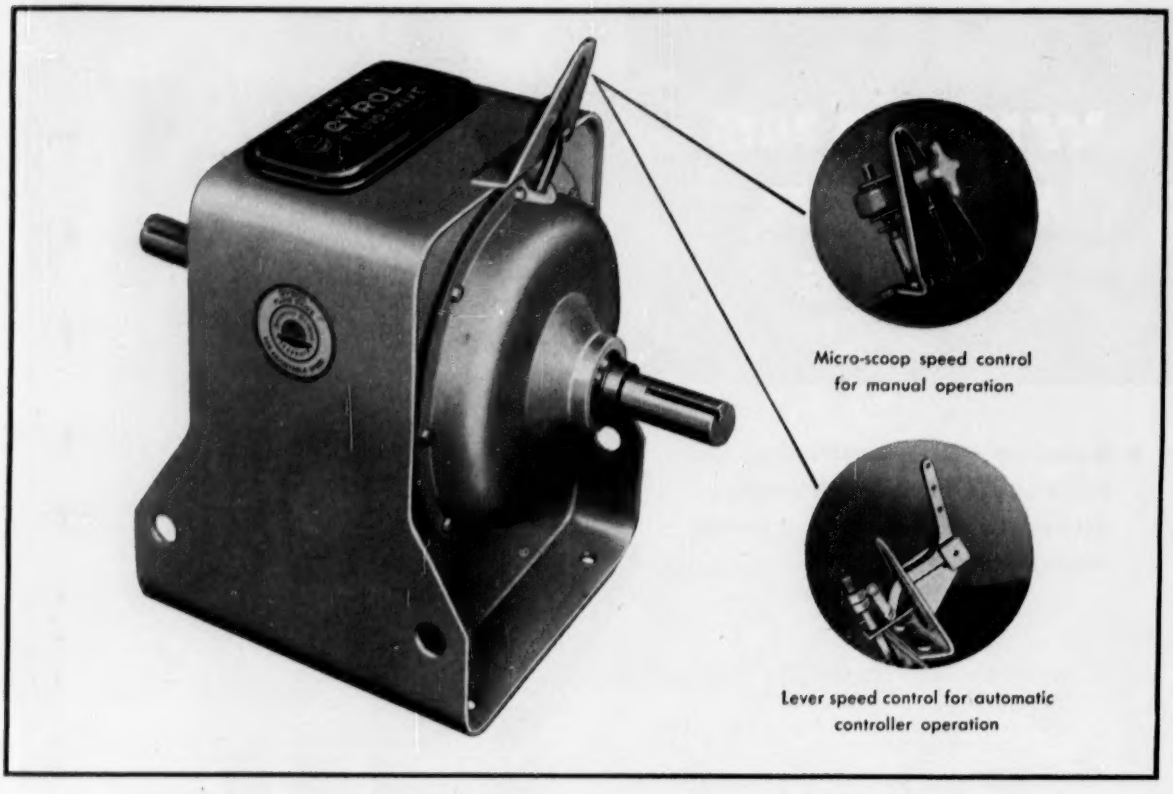
WILLIAMS PATENT CRUSHER & PULVERIZER CO.

2706 N. 9th St. St. Louis 6, Mo.

WILLIAMS

CRUSHERS GRINDERS SHREDDERS

Oldest and Largest Manufacturers of Hammer Mills in the World



American Blower *Gýrol*® Fluid Drives now available in lower horsepower ranges!

Type VS, Class 2 Gýrol Fluid Drives for 1- to 25-hp applications. Also available with flange-mounted motor, as shown.

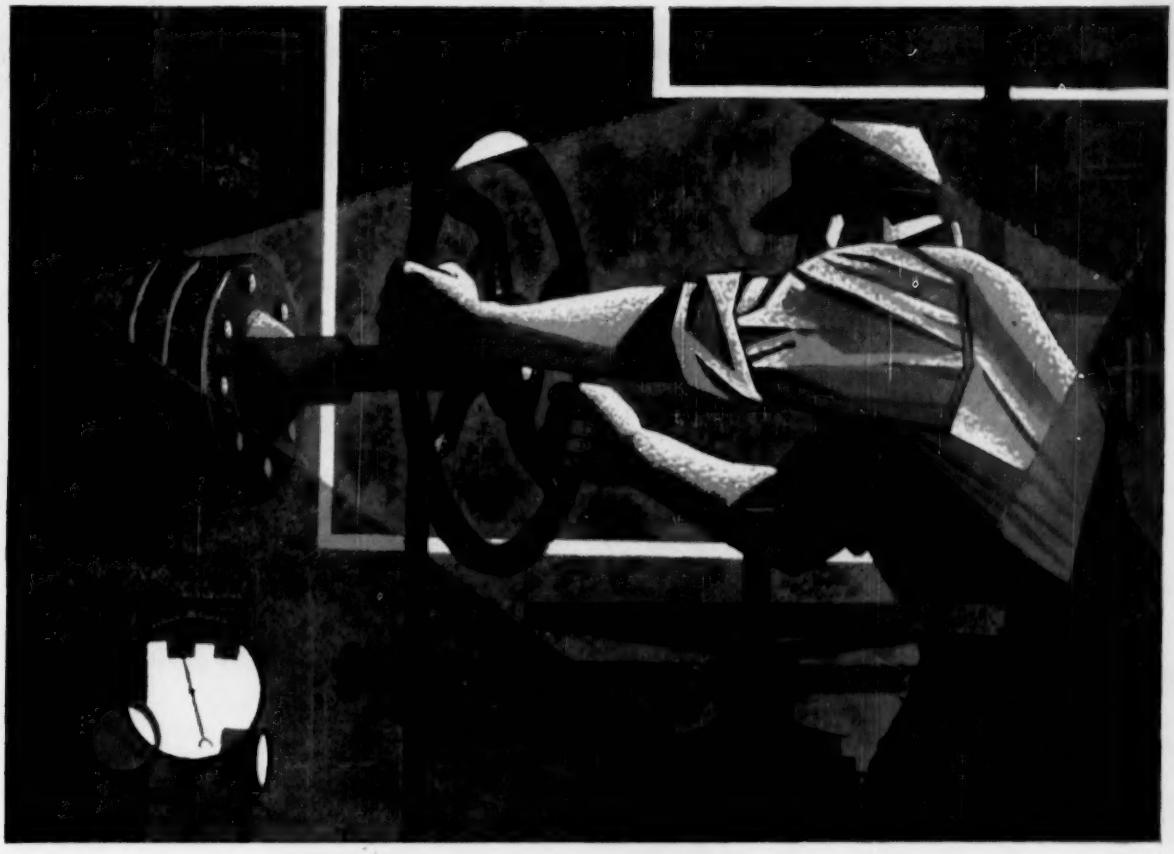
Adaptable to either automatic or manual control, American Blower Type VS, Class 2 Gýrol Fluid Drives come in a complete range of new smaller sizes—1 hp to 25 hp, speeds to 3600 rpm—to satisfy your every power-transmission need!

These compact, self-contained units offer an answer to many industrial-drive problems because of their important benefits: adjustable, stepless speed control; full reversibility; 5 to 1 speed range; no-load starting; protection against shock; quiet operation.

For full information on the complete line of Type VS, Class 2 Gýrol Fluid Drives, 1-800 hp—or other designs to 12,000 hp—contact our nearest branch office. Or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

AMERICAN BLOWER

Division of AMERICAN-Standard



Improved NEVILLE 2-50-W Hi-Flash Solvent brings you better finishes at lower cost

Neville's 2-50-W Hi-Flash Solvent has always been characterized as a superior, fully refined, water-white naphtha with a slow evaporation rate, good odor, high flash point and excellent solvency power. *Now, through improved control techniques, the solvency strength has been increased with no change in the product's low cost.*

And beyond solvency power, 2-50-W offers a number of other advantages to the manufacturer of alkyd finishes, aluminum paints, marine finishes, varnishes and enamels. It leaves no gummy residue to soften a finish, aids adhesion, hardens uniformly, and improves brushing, flowing and leveling characteristics. It aids in promoting surface tension control when used in aluminum paints, thereby promoting better leafing and leaf retention. 2-50-W is available for quick delivery in drums, transports or tank cars. For further information or a sample, please write to Neville Chemical Company.

NEVILLE

Neville Chemical Company · Pittsburgh 25, Pa.

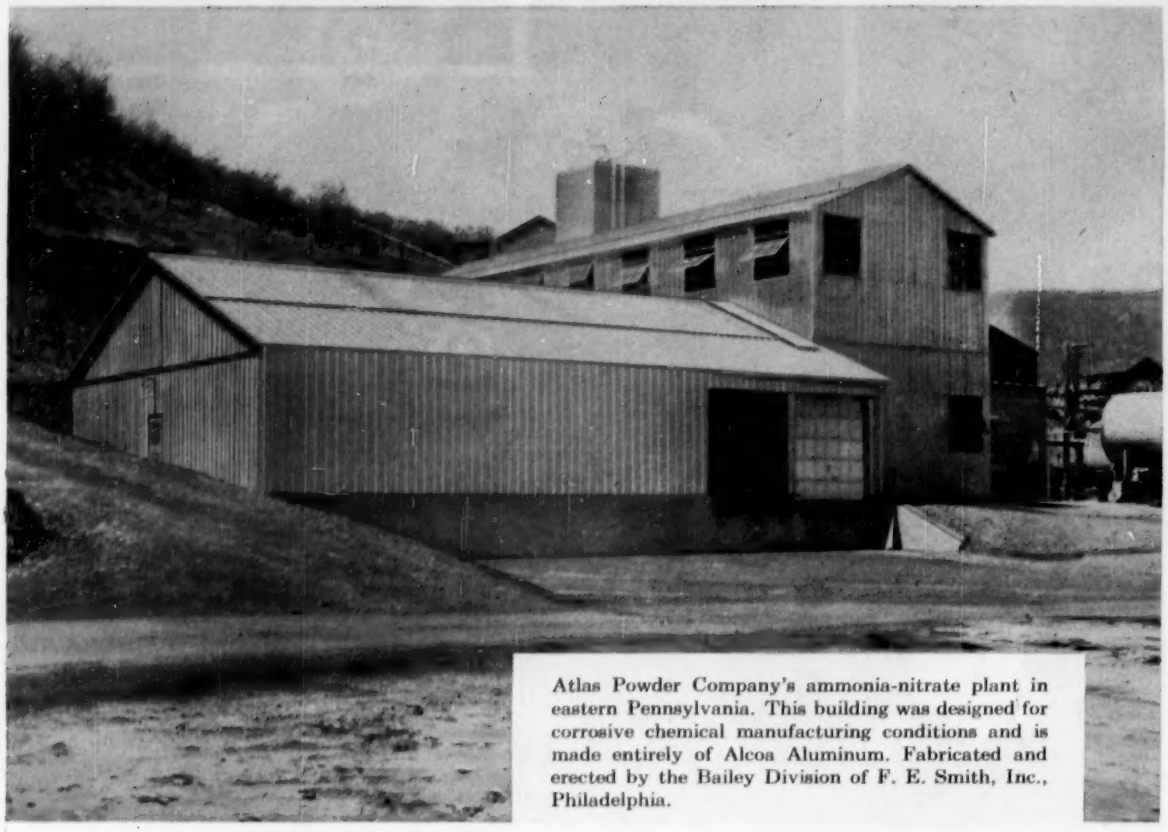
Please send information on Neville 2-50-W Hi-Flash Solvent.

Name Title

Company

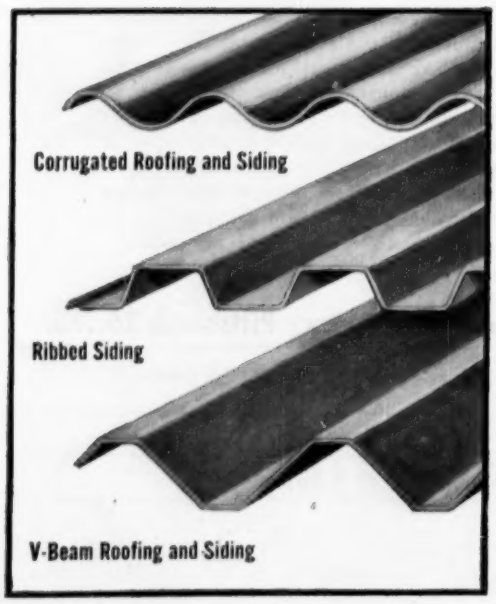
Address

City NC32CE State



Atlas Powder Company's ammonia-nitrate plant in eastern Pennsylvania. This building was designed for corrosive chemical manufacturing conditions and is made entirely of Alcoa Aluminum. Fabricated and erected by the Bailey Division of F. E. Smith, Inc., Philadelphia.

What else but aluminum for Atlas Powder's ammonia-nitrate plant!



Ammonia nitrate corrodes most metals, but not aluminum. That is why Atlas Powder built this all-Alcoa® Aluminum plant for ammonia-nitrate production. The entire building utilized an all-aluminum structural frame with a special Alcoa Aluminum corrugated sheet for roofing and siding . . . aluminum doors, windows, grating, electrical equipment, ducts and exhaust equipment. A duplicate plant is to be built for Atlas' new Joplin, Missouri, plant, too!

This experience is similar to other experiences by chemical companies who are finding the many advantages of aluminum-clad buildings that pay such handsome dividends, including no corrosion or maintenance problems. In fact, from the very start of a building of Alcoa Aluminum, you save money.

We'd welcome the opportunity to show you why. Just contact your nearest Alcoa sales office for complete details about building with versatile aluminum materials. We'll gladly recommend an Alcoa Approved Applicator for the job. Or write, Aluminum Company of America, 856-M Alcoa Building, Pittsburgh 19, Pa.

WE CHOSE ALCOA ALUMINUM MILL PRODUCTS

Your Guide to the Best in Aluminum Value

NEW! "ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

Lighter! Tighter!

LUNCOR PVC *VALVES*

Defy Corrosion!

FIG. 2601
SOCKET END
125 WP—140° F.

FIG. 2600
SCREWED END
125 WP—140° F.

Replace expensive high-alloy or glass-lined valves in your corrosive services with these money-saving, high-performance valves. Luncor is the first all-molded PVC valve designed and engineered by a valve manufacturer . . . and its low-cost performance is proved in handling most common corrosive solutions. Luncor Valves weigh only half as much as aluminum—one-sixth as much as bronze. Yet their high strength-weight ratio gives them rigidity comparable to metal. Luncor Valves are available in one-half inch through two inch sizes.

To list only a few . . . Luncor PVC Valves have established outstanding records for economy and service in the following operations:

- PAPER MILLS
- CHEMICAL PLANTS
- FOOD PROCESSING
- BEVERAGE BOTTLING
- PETROLEUM REFINING
- SUGAR REFINING
- WATER TREATMENT
- MARINE INSTALLATIONS

For detailed service recommendations . . . request a *Confidential Corrosion Service Information Form* from your Lunkenheimer Distributor, or from The Lunkenheimer Company, Box 360, Cincinnati 14, Ohio.

BRONZE • IRON • STEEL • PVC

L-857-9

LUNKENHEIMER QUALITY

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

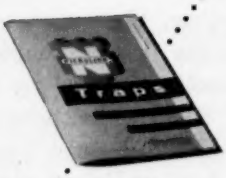
stop condensate backup

Nicholson steam traps discharge condensate and air from steam lines and equipment *faster* than any other trap of comparable size . . . help you make full use of your steam dollar. The reason—the effective use of a large orifice. A ½" Nicholson trap has a greater discharge capacity than most 1¼" traps . . . and costs less, too!

And that's not all. With just one thermostatically-operated moving part, there's nothing to get out of order, nothing to go wrong. Nicholson means continuous and low-cost operation of your steam-using equipment . . . no downtime from trap failure.

- **powerful valve action . . . no mechanical linkages to cause trouble.**
- **small and lightweight . . . easy to pipe and support.**
- **each unit steam-tested before shipment.**

So, to get a trap that discharges faster, saves money, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA. *Sales and Engineering offices in 98 principal cities.*



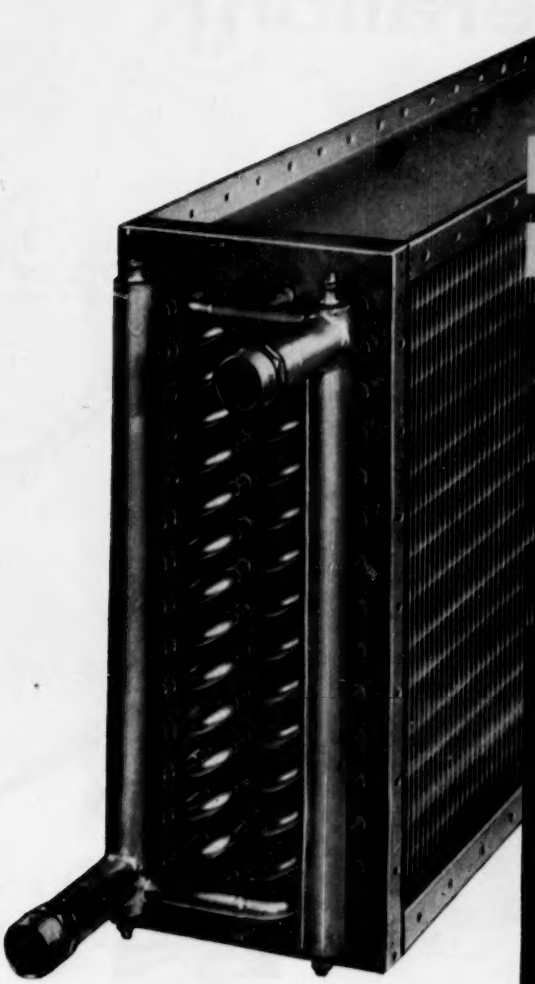
Write for Bulletin 1055

NICHOLSON
of Wilkes-Barre

STAINLESS STEEL

HEATING AND COOLING COILS

by MARLO



MADE TO YOUR EXACT

SPECIFICATIONS

To Heat and Cool Fluids

To Condense Gases

To Evaporate Liquids

Available with ½", ⅝", or ¾" O. D. Tubes

Coil Assemblies Available Up to 48¾" wide, 26" deep, 14-feet tube length and Fin Spacings of 4 to 10 per inch.

Other Stainless Steel Heat Transfer Equipment by Marlo for the Chemical Industry:
COOLING TOWERS • AIR WASHERS
EVAPORATIVE CONDENSERS

For More Complete Information, Send Coupon Attached to Your Letterhead.

MARLO

coil co.

SAINT LOUIS 10, MISSOURI

Quality Air Conditioning and Heat Transfer Equipment since 1925

MARLO COIL COMPANY

6137 Manchester Ave., St. Louis 10, Mo.

Please send me complete information on the following stainless steel Marlo heat transfer equipment.

☐ Heating and Cooling Coils ☐ Cooling Towers
☐ Evaporative Condensers ☐ Air Washers

NAME_____

COMPANY_____

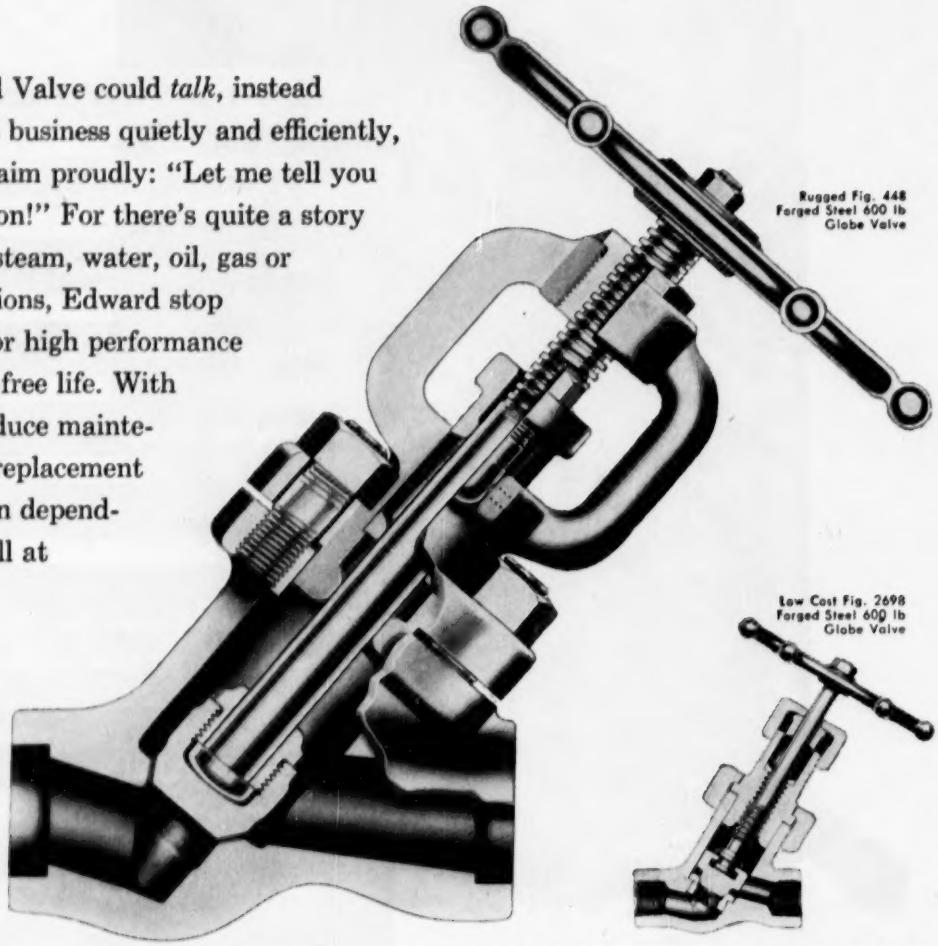
ADDRESS_____

CITY_____ ZONE___ STATE_____

Buying stop valves?

Let me tell you about my operation!

If an Edward Valve could *talk*, instead of going about its business quietly and efficiently, it might well exclaim proudly: "Let me tell you about my operation!" For there's quite a story to be told . . . in steam, water, oil, gas or chemical applications, Edward stop valves are built for high performance and long, trouble-free life. With them, you will reduce maintenance costs, cut replacement inventories, obtain dependable service . . . all at low initial cost.



FORGED STEEL body, bonnet, yoke add extra strength to Edward stop valves!

EVALLOY STAINLESS STEM resists corrosion!

EVALLOY HARDENED STAINLESS seat and disk last longer!

SWIVEL DISK prevents seat galling!

LARGE HANDWHEEL eases operation!

STAINLESS STEEL SWING GLAND BOLTS aid easy repacking!

POSITIVE BACKSEAT permits packing under pressure!

FOR FULL DETAILS on these and other Rockwell-Built Edward forged and cast steel valves, write for the Edward Condensed Catalog.

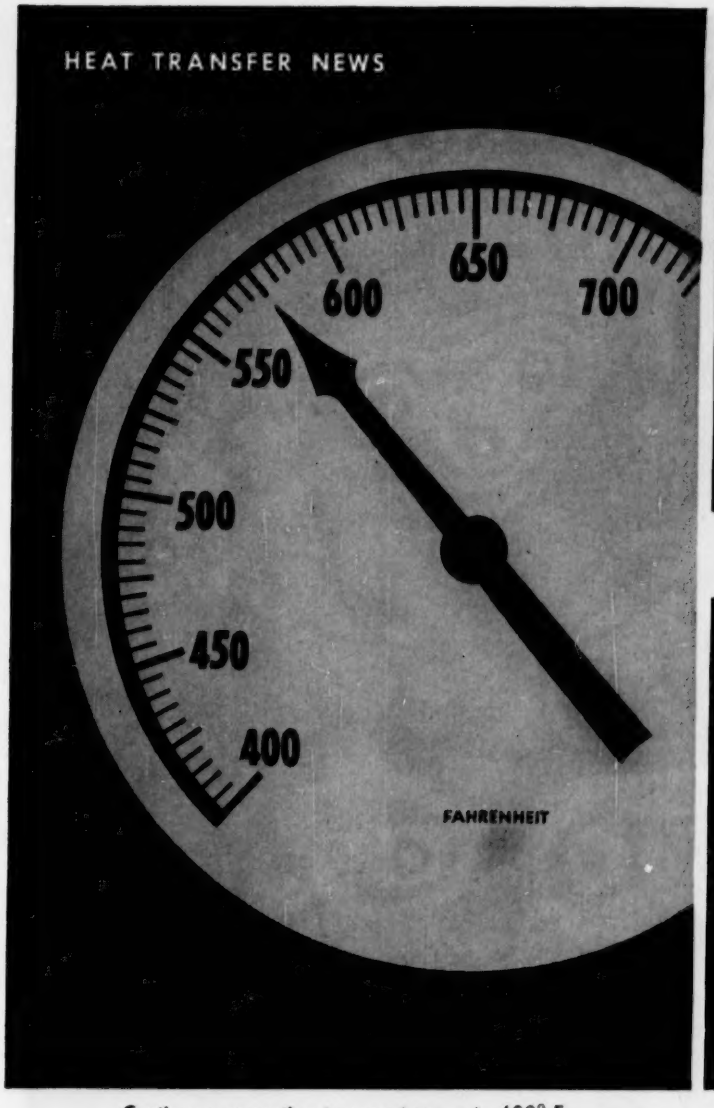
Edward Valves, Inc.

Subsidiary of

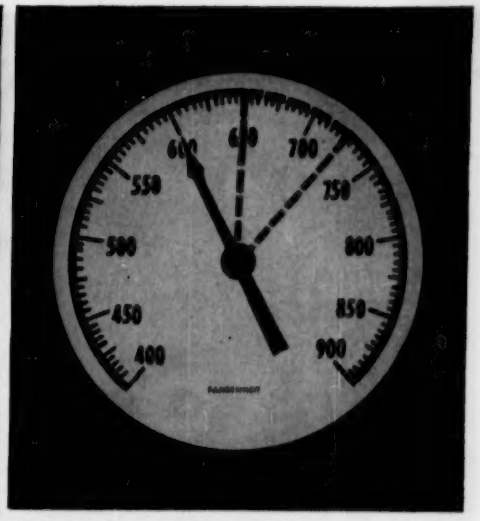
ROCKWELL MANUFACTURING COMPANY

1224 WEST 145TH STREET

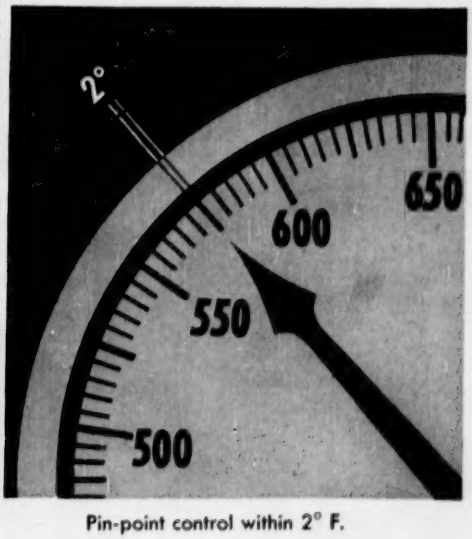
EAST CHICAGO, INDIANA



Continuous operating temperature up to 600° F.



Boiling range 652° to 725° F.—assures liquid at all times.



Pin-point control within 2° F.

Write Monsanto for sources of heating systems using Aroclor 1248... a non-pressurized, liquid-phase, heat-transfer fluid

Aroclor 1248 is a new kind of heat-transfer fluid that's fire-resistant and operates at atmospheric pressure.

The Equipment... Capacities can range from small portable units, usually electrically heated, to large gas- or oil-fired units generating from 250,000 to over 10,000,000 B.T.U.'s per hour. Circuits are closed, forced circulation. Compact design saves space, minimizes installation and maintenance costs.

The Fluid... Aroclor 1248 is a highly stable chlorinated polyphenyl; does not support combustion up to its boiling range 652° to 725° F.; has autogenous ignition temperature of extremely high 1299° F.; is non-corrosive. Aroclor 1248 operates in most systems four to seven years without replacement.

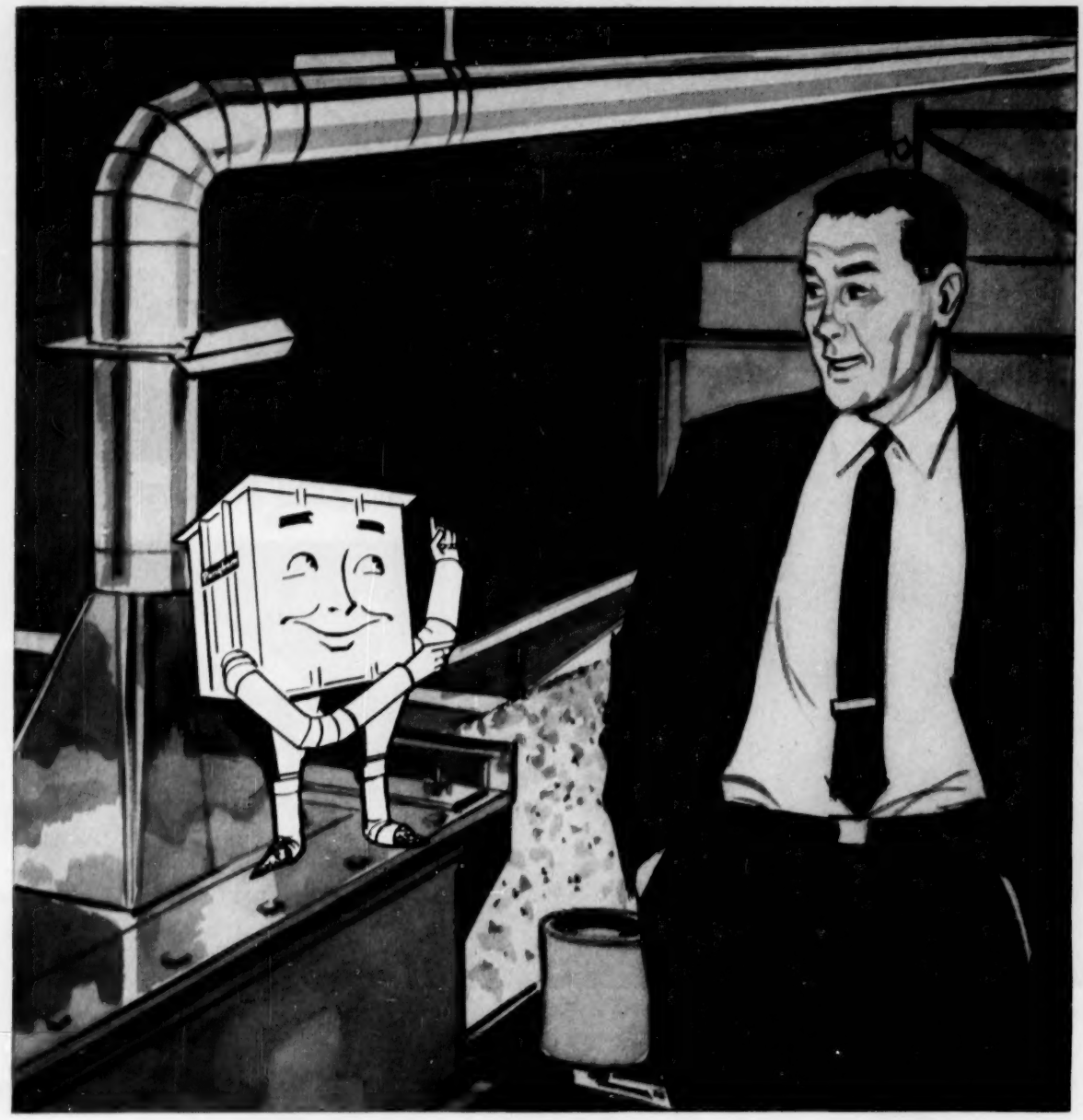
Monsanto will send you a list of designers and manufacturers of Aroclor 1248 equipment. Write today.

AROCLOR: Reg. U. S. Pat. Off.

Organic Chemicals Division
MONSANTO CHEMICAL COMPANY
Dept. IF-72, St. Louis 1, Missouri

MONSANTO

WHERE CREATIVE CHEMISTRY WORKS WONDERS FOR YOU



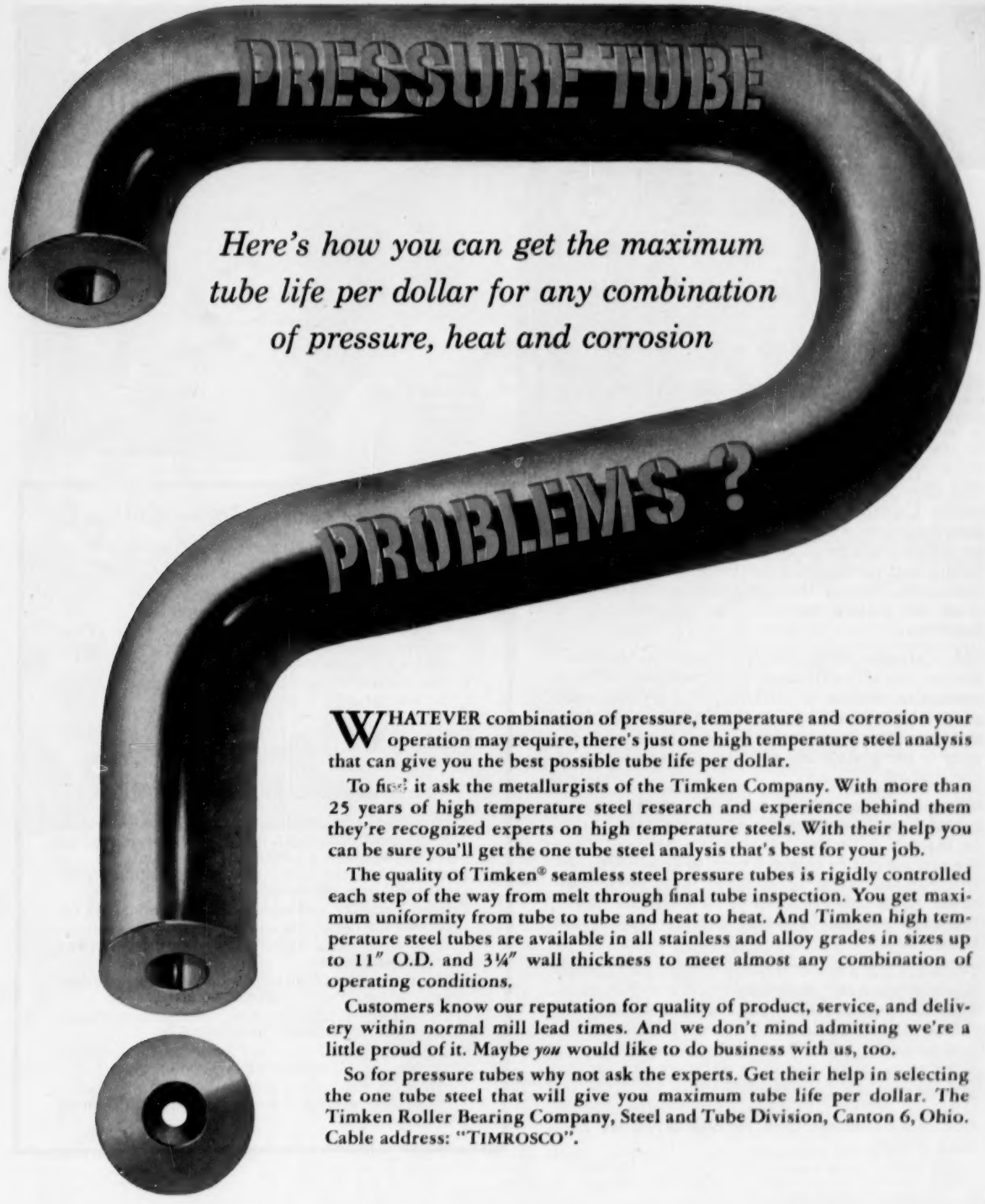
"What? A 15% increase in production machinery life?"

Yes, Pangborn Dust Control can increase your machinery life up to 15% or more! Pangborn Dust Collectors trap dust controlled at the source to prevent the abrasive wear and tear of uncontrolled dust settling in valuable equipment. Pangborn Dust Control can save you thousands of dollars by substantially lengthening the life expectancy of your machinery.

What's more, Pangborn gives you other benefits of lower housekeeping costs, higher employee efficiency, extra profits from any salvage value and better employee and community relations. And Pangborn offers a complete line of collectors, dry and *wet*, for all jobs.

Why not discover how you can profit from Pangborn Dust Control? Write for Bulletin 922 to: PANGBORN CORP., 2600 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control & Blast Cleaning Equipment.*

Pangborn CONTROLS DUST



Here's how you can get the maximum tube life per dollar for any combination of pressure, heat and corrosion

WHATEVER combination of pressure, temperature and corrosion your operation may require, there's just one high temperature steel analysis that can give you the best possible tube life per dollar.

To find it ask the metallurgists of the Timken Company. With more than 25 years of high temperature steel research and experience behind them they're recognized experts on high temperature steels. With their help you can be sure you'll get the one tube steel analysis that's best for your job.

The quality of Timken® seamless steel pressure tubes is rigidly controlled each step of the way from melt through final tube inspection. You get maximum uniformity from tube to tube and heat to heat. And Timken high temperature steel tubes are available in all stainless and alloy grades in sizes up to 11″ O.D. and 3¼″ wall thickness to meet almost any combination of operating conditions.

Customers know our reputation for quality of product, service, and delivery within normal mill lead times. And we don't mind admitting we're a little proud of it. Maybe *you* would like to do business with us, too.

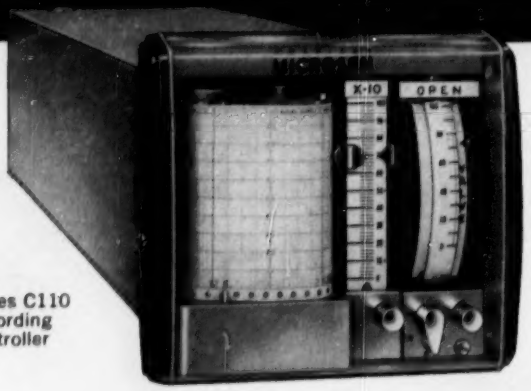
So for pressure tubes why not ask the experts. Get their help in selecting the one tube steel that will give you maximum tube life per dollar. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* STEEL

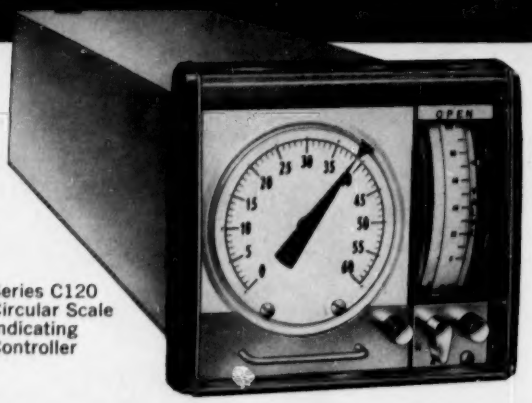
TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

NEW TRANSISTORIZED ELECTRONIC CONTROLLERS Interchangeable for complete versatility



Series C110
Recording
Controller



Series C120
Circular Scale
Indicating
Controller

The new 'American-Microsen' Series C100 Electronic Controllers can be interchanged at the panelboard in seconds. A recording controller to an indicating type . . . a proportional-action controller to proportional-plus-reset . . . slow reset to fast reset – any of these replacements is quickly made by pulling one unit out and plugging in the other.

The controller settings of the 'American-Microsen' System are all calibrated and repeatable. When a controller station is replaced, the proportional, reset and rate settings can be made in advance so the process is on control the instant the changeover is completed. No playing around to tune in the control.

When the process is on manual control during a replacement operation, the controller station stays in balance with the actual valve position. Thus the process can be changed back to automatic control without "bumping" or upset. A unique feature of the 'American-Microsen' System eliminates any "balance" or "seal" position between manual and automatic.

These are but a few of the many functional advantages of the new 'American-Microsen' Electronic Control System. Join the many satisfied users of this new approach to process control. Make certain you have the better control and simplified servicing so essential to higher product quality and greater operating economy. Arrange for a meeting with one of our sales engineers to determine the best equipment for your service. *Write for Bulletin RC100.*

Controller Performs These Functions

Measures input signal from transmitter and records or indicates in terms of the measured variable — pressure, temperature, flow, etc. (The Series C110 records on a 3-inch wide strip chart, the Series C120 indicates on a 4-inch diameter scale.)

Provides means of setting the desired value of the measured variable (set point) and compares actual value with desired value.

Transmits control signal, incorporating proportional, reset, and/or rate actions to operate final control element.

Provides means to operate control element manually with simple switch and manual knob.

Ultra-Modern Features Provided

All functions of recording (or indication), controlling (proportional, reset, and/or rate), and manual valve operation *in a single housing.*

Transistorized controller station for ultimate reliability and long service life.

Printed circuitry and miniaturized components for space-saving simplicity.

Plug-in units for complete interchangeability and ease of maintenance.

Ratio, cascade, and other similar control arrangements, using standard instruments.

Direct bumpless transfer from manual to automatic control with no intermediate position.

DC signals of 1.0 to 5.0 milliamperes for instantaneous distance transmission up to 30 miles.

Controllers are compatible with any unit of other manufacture using the standard 1 to 5 milliampere DC signal.

MANNING, MAXWELL & MOORE, INC.

MAXWELL MANNING & MOORE INC. M&M TRADE MARK

INDUSTRIAL CONTROLS DIVISION • STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

New chain has steel's strength plus nylon's wear resistance

NY-STEEL FLAT TOP CHAIN on Horix Fitting Machine with nine fitter valves. This unit is in service at Mangels Herold Company, Baltimore, manufacturers of King Liquid Laundry Starch.

Link-Belt Ny-Steel flat-top chain fits existing sprockets

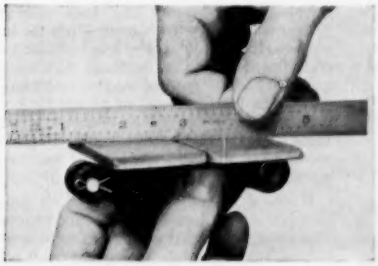
Nylon and Steel — Link-Belt combines both in Ny-Steel Flat-Top Roller Chain. This combination gives you a smooth, resilient nylon carrying surface to reduce glass breakage and track wear — plus a precision steel roller chain with the strength and durability to carry heavy loads without stretching. Ny-Steel is less than half the weight of similar all-steel chain — has proven itself ideal for safe, low-cost conveying of bottles, cans and similar items.

Exceptional wear-life

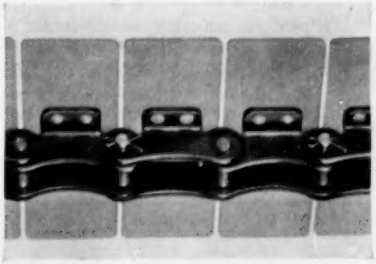
Long life is one of Ny-Steel's many outstanding features. It resists chemicals and corrosion . . . retains pitch, even under moisture conditions . . . gives long-lasting service with practically no top-plate or track wear.

Ny-Steel is easy to install . . . fits existing sprockets. And for new installations or replacements, Link-Belt makes a full line of cut-tooth sprockets. Ny-Steel comes with top plates assembled on either stainless or heat-treated carbon steel chain.

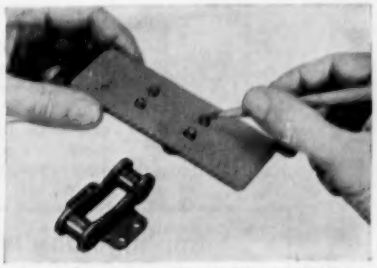
Why Ny-Steel is industry's most advanced flat-top conveyor chain



RIVET-FREE SURFACE — Top plates are of uniform thickness, without rivet pockets or projections. Each is chamfered and mounted level with adjacent plates.



PRECISION STEEL ROLLER CHAIN gives Ny-Steel its great strength . . . facilitates installations and maintenance. Can be easily coupled or uncoupled.



SECURE BONDING OF CHAIN AND PLATE — Underside of each plate is molded with projections that become self-rivets. This leaves surface free of obstructions.

The large picture above illustrates one of many applications of Ny-Steel flat-top chain. Besides being smooth, nylon plates are shock-absorbent . . . assure safe, easy transfer of containers.

Ny-Steel top plates are available in 3¼ and 4½-in. widths. Folder 2492 contains complete dimensions and specifications.

HEADQUARTERS for Link-Belt products is your nearby Link-Belt factory branch store or authorized stock-carrying distributor. Refer to the yellow pages of your local phone directory.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.749

Using Salt Efficiently

by **INTERNATIONAL SALT COMPANY, INC.**—America's largest producer of salt

How to Sample Rock Salt for Screen or Chemical Analysis

Sampling bulk rock salt accurately is often a difficult problem. For when salt is stored in piles, coarser particles collect at the foot of the pile—while finer particles remain inside and at the top. A few handfuls of salt taken at random from the outside and bottom of such a pile almost always mean an inaccurate sample for analysis. Also, during transportation and handling, salt particles of different sizes tend to become segregated.

However, by following a few simple steps, you can easily obtain salt particles of a truly representative size range. This sample will then give accurate results in any type of screen or chemical analysis. Here are the modern sampling techniques approved for most plants where salt is used:

Stockpile sampling of bulk salt. Samples from either indoor or outdoor stockpiles should be taken at three separate points: at the top of the pile, at the base, and at one intermediate point. The sample taken at the intermediate point must come from deep within the pile. To prevent segregation of salt particles during this sampling procedure, a board should be pushed into the salt pile just above the point from which the sample is taken.

Sampling bulk salt in railroad cars or trucks. In sampling a boxcar load of salt, three trenches should first be made in the salt across the width of the car. The bottom of each trench should be at least 1 ft. below the surface of the salt, and approximately 1 ft. wide. Equal portions of salt can then be taken from nine equally spaced points along the bottom of each trench. Two of the nine points should be directly against the sides of the boxcar. Sampling in these trenches is best accomplished by pushing a shovel or sampling tube directly into the salt, and not by scraping horizontally.

The same general procedure may be used effectively to sample truckloads of rock salt.

Sampling between transport and storage. Rather than sample bulk salt in cars or in storage, many companies feel that more accurate samples can be taken during unloading—at some point in the handling process where a flowing stream of salt is accessible on all sides. The points at which salt leaves a head pulley or drops from a chute lip are two of the most desirable places for this type of sampling.

This "running sample" gives consistently excellent results, but it must meet the following conditions as closely as possible:

1. To obtain salt particles of all sizes, the sampling scoop must move at uniform rate across the entire *width* of the stream. Samples will generally be inaccurate if the scoop moves through the stream from front to rear.

2. The sampling interval should be uniform. And it is better to take small samples frequently than a few large samples.

3. The sampling scoop should have a relatively long rectangular opening, permitting a knife-like cut across the stream. The use of pails or shovels to sample the stream may produce an inaccurate sample.

4. Sampling should take place on a regular stream flow. When taken from an intermittent flow, samples may not be representative. Also, sampling should be carried on throughout the entire unloading period.

Moisture content. Samples should not be taken from bulk rock salt which has recently been exposed to rainfall or excessive humidity. Under these conditions, the proportion of insolubles will increase due to the leaching out of a certain amount of salt. Resulting analysis will then show a higher degree of impurities and a lower sodium chloride content than is normally present.

Finally, it must be remembered that no matter where the salt is sampled—the larger the sample taken, the more representative it will be for final analysis. In fact, many industries require a gross sample of at least 100 lb. from one carload of salt. This sample is then reduced to about 5 lb. for laboratory work.

TECHNICAL SERVICE WITH YOUR SALT

Through skilled and experienced "Salt Specialists," International can help you get greater efficiency and economy from the salt you use. International produces both Sterling Evaporated and Sterling Rock Salt in all grades for industry. And we also make automatic dissolvers in metal or plastic for both types of salt. So we have no reason to recommend one type of salt over another; we simply recommend the type and size of salt most perfectly suited to your needs.

If you'd like the assistance of an International "Salt Specialist" on any problem concerning salt or brine—or further information on salt sampling and analysis—just contact your nearest International sales office.

International Salt Co., Scranton, Pa.
Sales Offices: Atlanta, Ga.; Chicago, Ill.; New Orleans, La.; Baltimore, Md.; Boston, Mass.; Detroit, Mich.; St. Louis, Mo.; Newark, N.J.; Buffalo, N.Y.; New York, N.Y.; Cincinnati, O.; Cleveland, O.; Philadelphia, Pa.; Pittsburgh, Pa.; and Richmond, Va.

Sampling Tube Is the Simplest Method

Most sizes of rock salt can be sampled from stockpile, bins, trucks, or railroad cars by means of a simple sampling tube approximately 1¼" in diameter and about 6 ft. long. Five to eight insertions of this tube into the salt will furnish a sample of about 10 lb. Some of the best tubes for sampling rock salt are those sold for testing grain. They have about 12 openings and a special auger point.

FOR INDUSTRY, FARM AND THE HOME—
STERLING SALT
PRODUCT OF INTERNATIONAL SALT CO., INC

Send for this new folder

Learn the facts about money-saving, custom-engineered SOLA-FLEX® expansion joints

FORTY OF AMERICA'S fifty largest businesses are users of Sola-Flex expansion joints. They know that Sola-Flex joints are custom-engineered to meet every piping need, no matter how tough the temperature or pressure demands. And Sola-Flex joints are economical, too—in initial cost and long life.

They are made from a variety of stainless and high alloys, from ½ inch to 35 feet in diameter. They handle pressures up to 3500 psi for special applications. And they are being built for service from −320F to 1200F.

It will pay you to learn more about Solar's complete line of industrial bellows and expansion joints. Send for this new folder today. Write to Department D-109, Solar Aircraft Company, San Diego 12, California. *Designers, developers and manufacturers of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

FOR NEW SOLA-FLEX FOLDER MAIL TO:
Dept. D-109, Solar Aircraft Company, San Diego 12, California

NAME _____

TITLE _____

COMPANY _____

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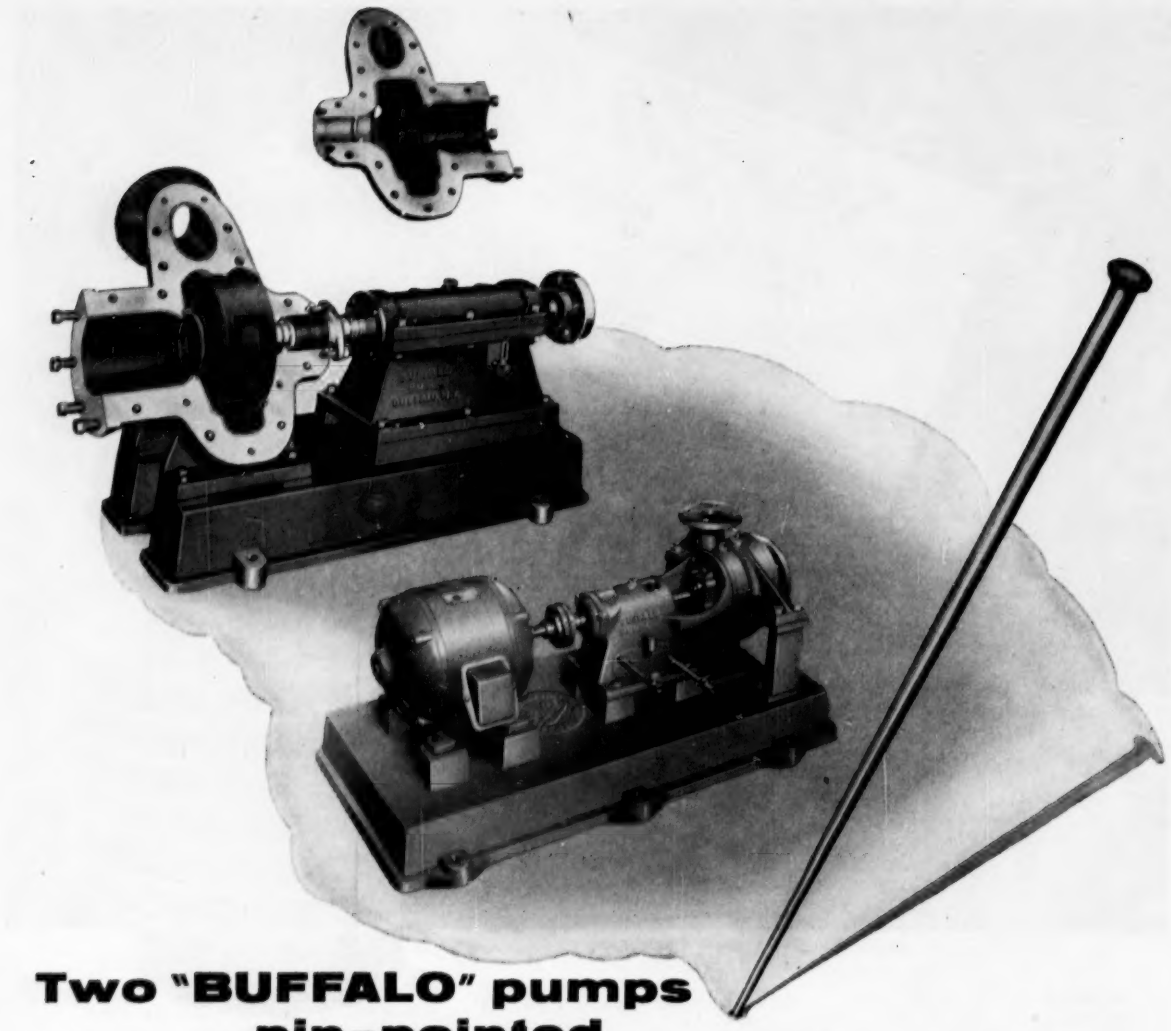
ENGINEERS WANTED. *Unlimited opportunities, challenging projects, good living with Solar! Send for new brochure.*



Two "BUFFALO" pumps pin-pointed to the needs of the Chemical Industry

For Pumping Corrosives or Solutions Containing Abrasive Solids:

"BUFFALO" TYPE "DS" RUBBER-LINED PUMP

- **NON-CORROSIVE** — Rubber permanently bonded to the impeller and all liquid passages insures long, trouble-free life . . . reduces down-time and replacement costs.
- **NON-CLOGGING** — The shrouded impeller is highly efficient . . . does not depend on close running tolerances.
- **EASY-TO-SERVICE** — Top of diagonally-split pump casing is quickly removed for easy inspection and servicing.
- **HUSKY, DEPENDABLE CONSTRUCTION** — including heavy pump and bearing stands, ample stuffing box and bearing oil reservoir.

There's a "Buffalo" Type "DS" Pump to handle *your* "problem" liquids economically. Write today for Bulletin 982.

For Pumping High Temperature Liquids:

"BUFFALO" HIGH TEMPERATURE PUMP

- **Water-Cooled Bearings and Stuffing Boxes**
- **Cast Steel Casings and Side Plates . . . full center-line support**
- **Special Packing (Mechanical Seals if Specified)**
- **Smothering Gland**
- **Flexible, All-Steel Coupling**
- **Colmonoy-Coated Shaft Sleeve Thru Stuffing Box**

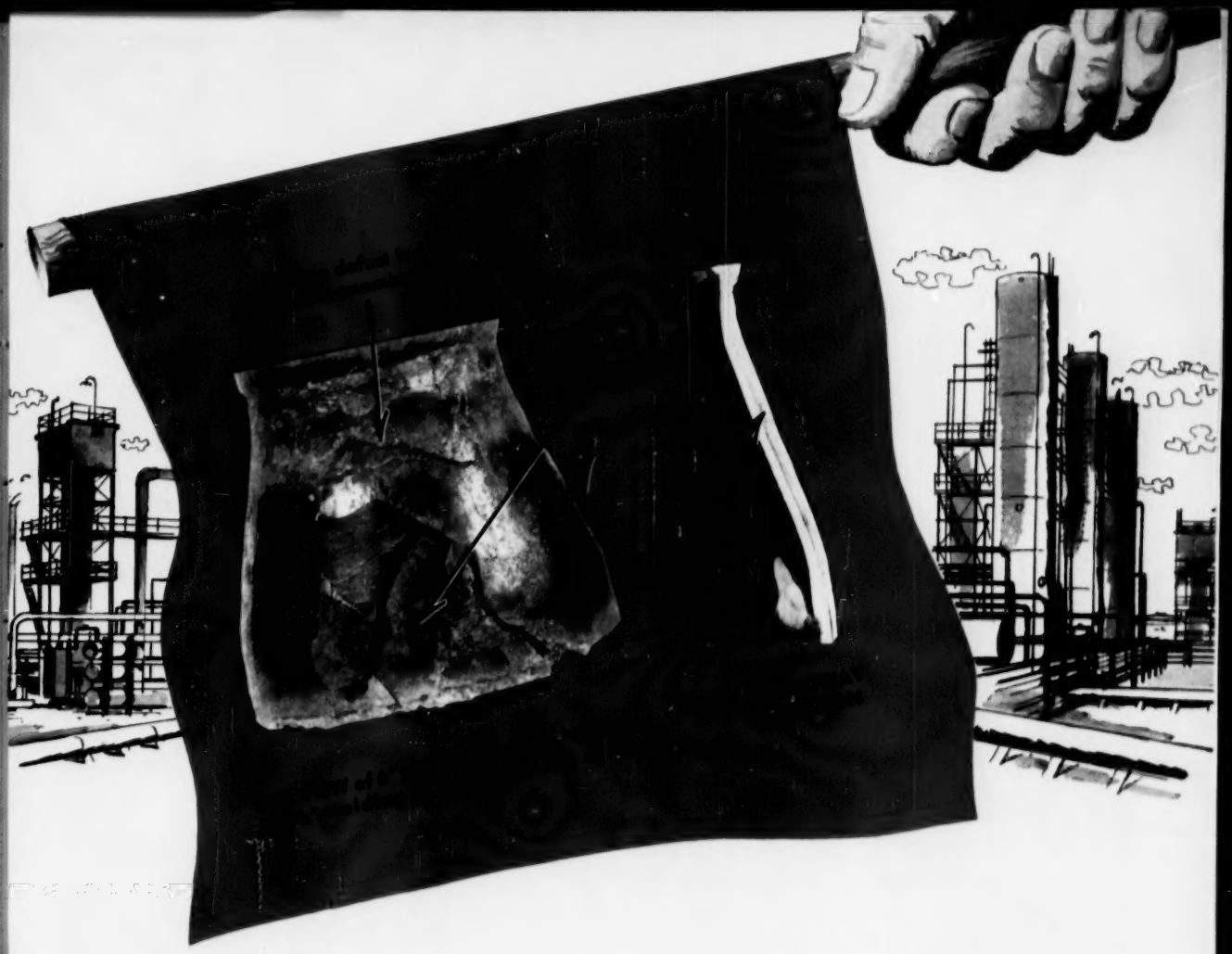
Do *you* have a problem in moving high temperature liquids? Then, by all means, write today for our recommendations . . . based on 80 years of engineering experience.

"Buffalo" Pumps Feature the Famous "Q" Factor — the Built-In *Quality* which Provides Trouble-Free Satisfaction and Long Life.

"Buffalo" PUMPS

BUFFALO PUMPS Division of Buffalo Forge Co.
501 Broadway Buffalo, N. Y.
Canada Pumps, Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



Watch out for the after-costs of Question Mark fittings!

Unknown fittings may look like a bargain on the price tag, but watch out for the consequences!

Surface defects led to the above "Question Mark" fitting being cut from the piping. Further examination showed the steel inside was laminated. Pieces cut out literally fell apart. Here was an open invitation to serious trouble . . . lost production, wasted dollars and possible human casualties.

This is another example of a dangerous situation posed by unknown fittings of questionable quality . . . a serious threat to the safety and economy of well-engineered piping.

You can avoid these risks by specifying KNOWN fittings!

DANGER! *Your first warning of Question Mark fittings is their lack of complete, permanent identification of manufacturer, wall thickness, weight, material . . . as required by A.S.A. code.*

A message in the interests of top quality piping
. . . by Tube Turns, Louisville, Kentucky

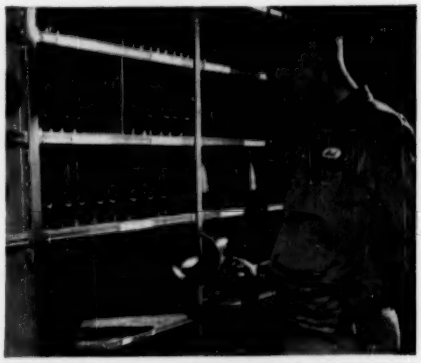
YOUR SAFEGUARD

Safeguard your piping investment with known fittings!

TOP QUALITY! *Directional and size changes in this process piping are made with TUBE-TURN Welding Elbows and Reducers . . . recognized for their unsurpassed uniformity and quality.*

The cost of fittings is a small fraction of the total cost of a piping system. To buy "cheap" fittings and run the risk of impairing the performance of your entire system can, therefore, be "penny wise and pound foolish."

When you specify and buy TUBE-TURN* products, you know your investment is safeguarded by unsurpassed quality of fittings and flanges. They meet all American Standard and Safety Code requirements. Each product is permanently marked with complete size and material designation.



COMPLETE LINE! *Your nearby Tube Turns' Distributor gives you prompt delivery from the complete line of more than 12,000 Tube Turns' stocked items. Photo courtesy The Ross-Willoughby Co., Columbus, Ohio.*

TUBE TURNS, Dept. H-9
224 East Broadway, Louisville 1, Kentucky

Please send new Standard for Butt-Welded Carbon Steel Piping Systems.

Company Name _____

Company Address _____

City _____ *Zone* _____ *State* _____

Your Name _____

Position _____

Available from your nearby TUBE TURNS' distributor

*"TUBE-TURN" and "t" Reg. U.S. Pat. Off.

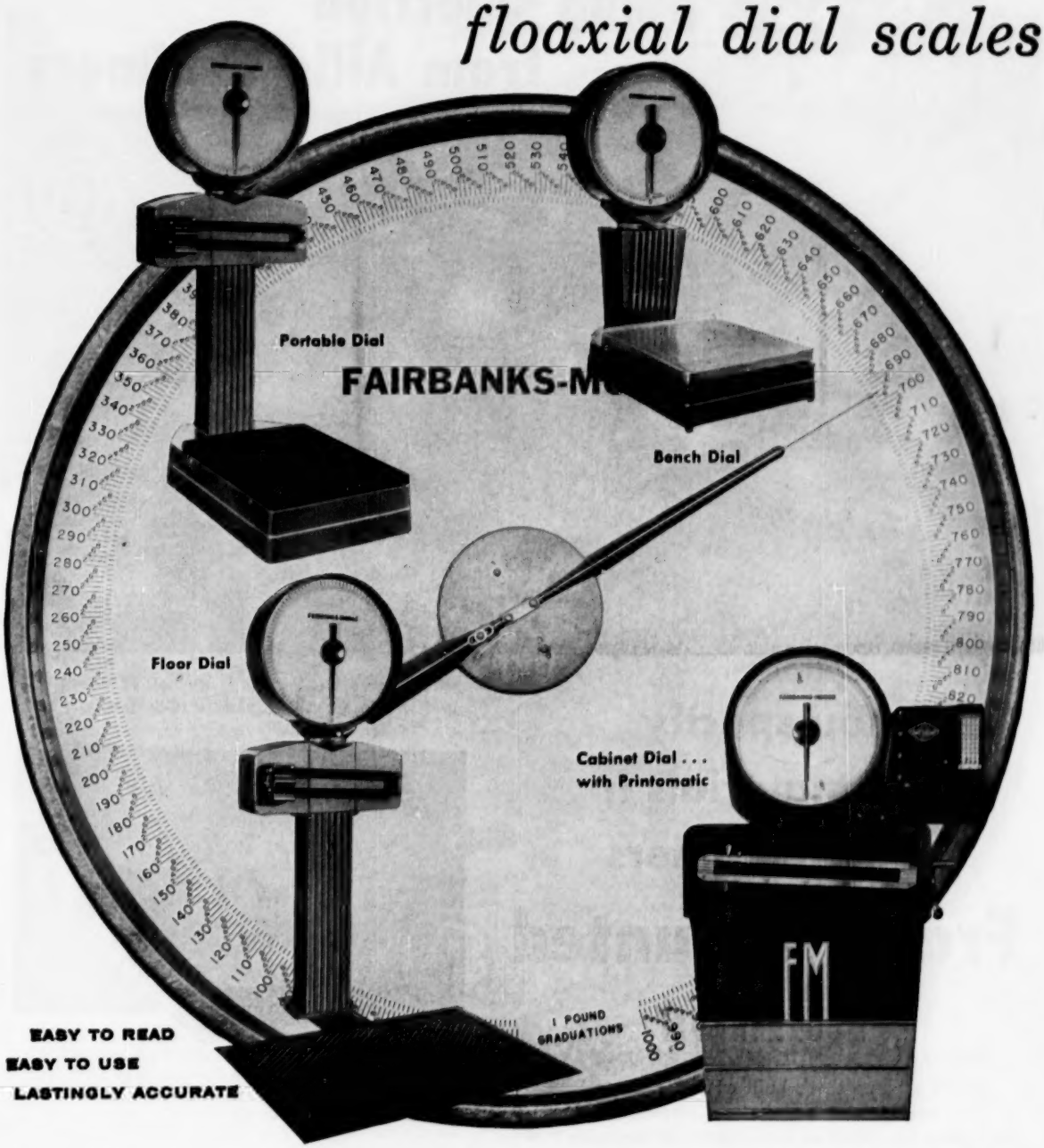
TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland • Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle
In Canada: Tube Turns of Canada Ltd., Ridgetown, Ontario • Toronto, Ontario • Edmonton, Alberta • Montreal, Quebec

NEW... Fairbanks-Morse floaxial dial scales



Fairbanks-Morse engineers designed this new dial line with your needs in mind . . . based on exhaustive field reports. They're streamlined . . . easy to read . . . easy to use . . . rugged to resist shock loads and rough handling . . . easy to service and maintain. And, above all, they have the new, patented *Floaxial* dial mechanism that assures enduring accuracy. There are no knife edges or pin-point pivots to wear and affect long-life accurate weighing.

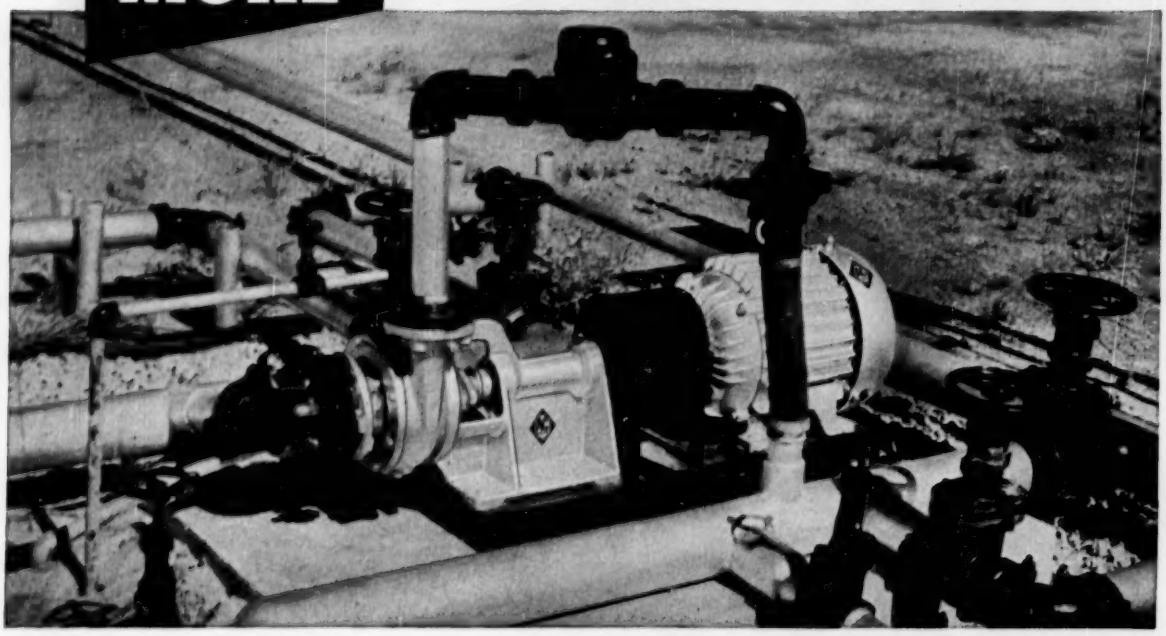
Dial chart and indicator are designed for easiest reading—ever! There's nothing to distract the eye . . . you get faster, easier weight indication. Dial head swivels a full 360 degrees.

Get the full story from your Fairbanks-Morse Scale Expert or write on your letterhead for a copy of new, colorful bulletin that describes the full line of Floaxial Scales. Address Fairbanks, Morse & Co., Dept. CE-12, 600 South Michigan Ave., Chicago 5, Ill.

FAIRBANKS-MORSE
a name worth remembering when you want the best

SCALES • PUMPS • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICITY MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

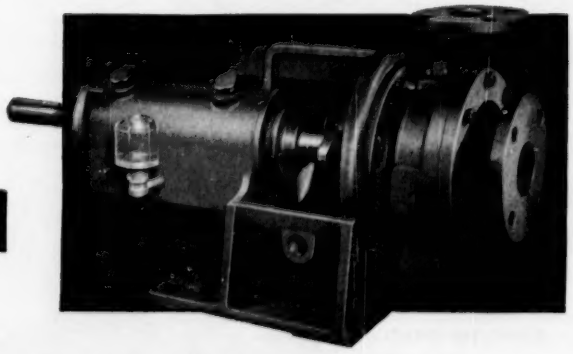
There's MORE pump selection from Allis-Chalmers



Handling corrosive liquids is the job of this A-C pump driven by an Allis-Chalmers 10-hp motor.

You specify the materials in Allis-Chalmers

Frame-Mounted Pumps



Frame-mounted pumps, either grease or oil lubricated, are available with heads to 400 ft, capacities to 3500 gpm, temperatures to 550 F.

Here's a pump that's built exactly right to handle *your* problems of temperature, corrosion and contamination. Reason: *You* specify the materials that go into *your* Allis-Chalmers pump.

Parts are available in almost every material used in pump construction — iron, bronze, stainless steel, high nickel alloys and others. In addition, you pick the sealing arrangement and specify direct coupling or V-belt drive.

Lower cost per gallon pumped results from the custom design of Allis-Chalmers pumps—and they're priced well below "special" chemical and refinery pumps. Next time you need pumping equipment, talk with an A-C pump specialist. Contact your nearest A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

A-5301

ALLIS-CHALMERS

IF YOU ARE USING A MAGNESIUM MATERIAL...

...you can improve operating efficiencies, cut costs and increase product quality with...

HIGH PURITY 99.0+% MAGNESIUM OXIDE

International MgO may offer you unexpected advantages as a replacement for other material or for a new application. It has unusual versatility in performance characteristics—and is produced in the highest purities ever available in carload quantities and in the low price range. Our research staff offers you technical assistance on end use problems and in the application of MgO to your production processes.

price range

International MgO prices range from $110 to $250 per ton, F.O.B. Carlsbad, depending on grade, packaging and quantity.

INTERNATIONAL MgO HAS DEMONSTRATED ITS SUPERIORITIES FOR THESE AND OTHER USES

- *As an alkali precipitant.*
- *As a compounding agent in rubber formulations.*
- *As a furnace feed for special fused refractories.*
- *In the manufacture of high purity magnesium compounds.*
- *For blending with other magnesias.*

INTERNATIONAL MINERALS *International* MINERALS CHEMICALS **& CHEMICAL CORPORATION**

POTASH DIVISION .... 20 N. Wacker Drive, Chicago 6

485 LEXINGTON AVE., NEW YORK 17 • MIDLAND, TEXAS • FULTON NATIONAL BANK BLDG., ATLANTA, GA.

physical specifications
(Color . . . White)

PELLETS:	Approx. ⅛" x ⅜", plus 12 mesh Bulk density: 60 lb. cu. ft.
GRANULAR:	All minus 12 mesh Bulk density: 70 lb. cu. ft.
POWDERED:	100% minus 200 mesh 90% + minus 325 mesh Bulk density: 80 lb. cu. ft.

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
20 North Wacker Drive, Chicago 6

☐ Please send me samples of MgO in ..... form
(pellet – granular – powdered)

☐ Please send Magnesium Oxide Brochure
My field of interest for MgO is .....

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☐ **Modern Instruments in Chemical Analysis** by Frank M. Biffen and William Seaman. Publisher's Price, $7.50. Club Price, $6.40.

☐ **Tables of Integral Transforms,** VOLUME I, edited by A. Erdelyi. Publisher's Price, $7.50. Club Price, $6.40.

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CE-12-57

This offer is available only in the United States and its possessions. In Canada write McGraw-Hill Canada, 253 Spadina Road, Toronto 4.

Wherever valves are attacked by acids, salt and alkaline solutions, sea water, brine or other corrosive fluids, vapors or gases, "Jenkins Ni-Resist Gate Valves" are *fighting* words.

In a wide range of corrosive and erosive services common to the chemical, food, plastics, marine, petroleum, and pulp and paper industries, these valves have shown a remarkable ability to withstand corrosion and cut valve costs.

The secret of their long, trouble-free service is the combination of Ni-Resist type 2 cast iron and type 316 stainless steel trim, plus Jenkins *extra value* construction throughout. No other gate valves offer this combination for fighting corrosion.

When choosing Ni-Resist valves, let the famous Jenkins Diamond be your guide. Specify "JENKINS NI-RESIST" — for longer valve life. Write us, or ask your Jenkins Distributor for information folder No. 205. Jenkins Bros., 100 Park Avenue, New York 17.

A Bronze yoke bushing nut
B Handy grip iron wheel
C Bronze yoke bushing
D Iron yoke cap with zerk fitting for lubricating bushing
E Steel yoke cap bolts and nuts
F TYPE 316 STAINLESS STEEL spindle
G NI-RESIST CAST IRON, TYPE 2, yoke
H Bronze eye bolt nuts
I Malleable iron gland flange
J Steel gland eye bolts
K Steel gland lug bolts and nuts
L TYPE 316 STAINLESS STEEL gland
M Teflon impregnated asbestos packing
N TYPE 316 STAINLESS STEEL bonnet bushing
O NI-RESIST CAST IRON, TYPE 2, bonnet
P Steel bonnet bolts and nuts
Q TYPE 316 STAINLESS STEEL spindle ring
R Asbestos gasket
S TYPE 316 STAINLESS STEEL wedge pin
T NI-RESIST CAST IRON, TYPE 2, through-port body
U TYPE 316 STAINLESS STEEL solid I-beam wedge
V TYPE 316 STAINLESS STEEL seat rings

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
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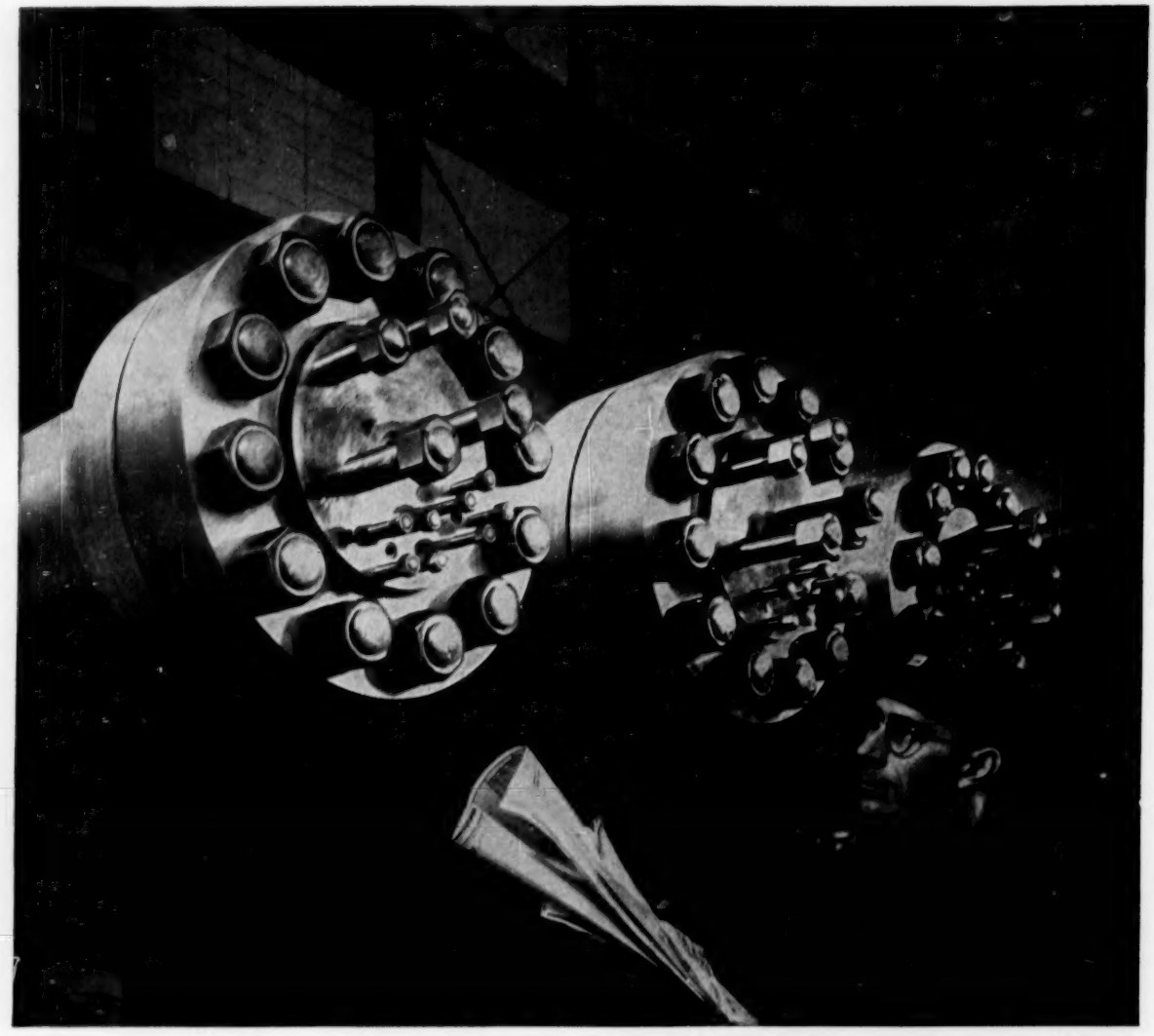
Sold Through Leading Distributors Everywhere



These three will help make synthetic fibers

The three forged separators shown above will be used in the making of synthetic fibers. They will handle pressures between 8,000 and 9,000 psi.

Built by Bethlehem, the vessels are almost in the midget class. They do not have to be big for the work they will do. Each of them is 94 in. long and weighs approximately two tons. But there is an old saying that good things come in small packages, and this is a case in point. The vessels, though small, are exceptionally sturdy. Every component is strong, down to the last stud and nut.

It's quite possible that you yourself may never need to purchase vessels as small as these. But Bethlehem can handle your requirements, whatever they may be. We are equipped to forge, heat-treat, and machine pressure vessels of any size, even those weighing 150 tons and more.

When you are planning separators, autoclaves, reactors, filters, converters, or high-pressure accumulators, feel free to consult with our staff of engineers. You will find these technicians helpful, cooperative, and able to work in complete harmony with your own people.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

for the most efficient recovery of platinum metals . . .

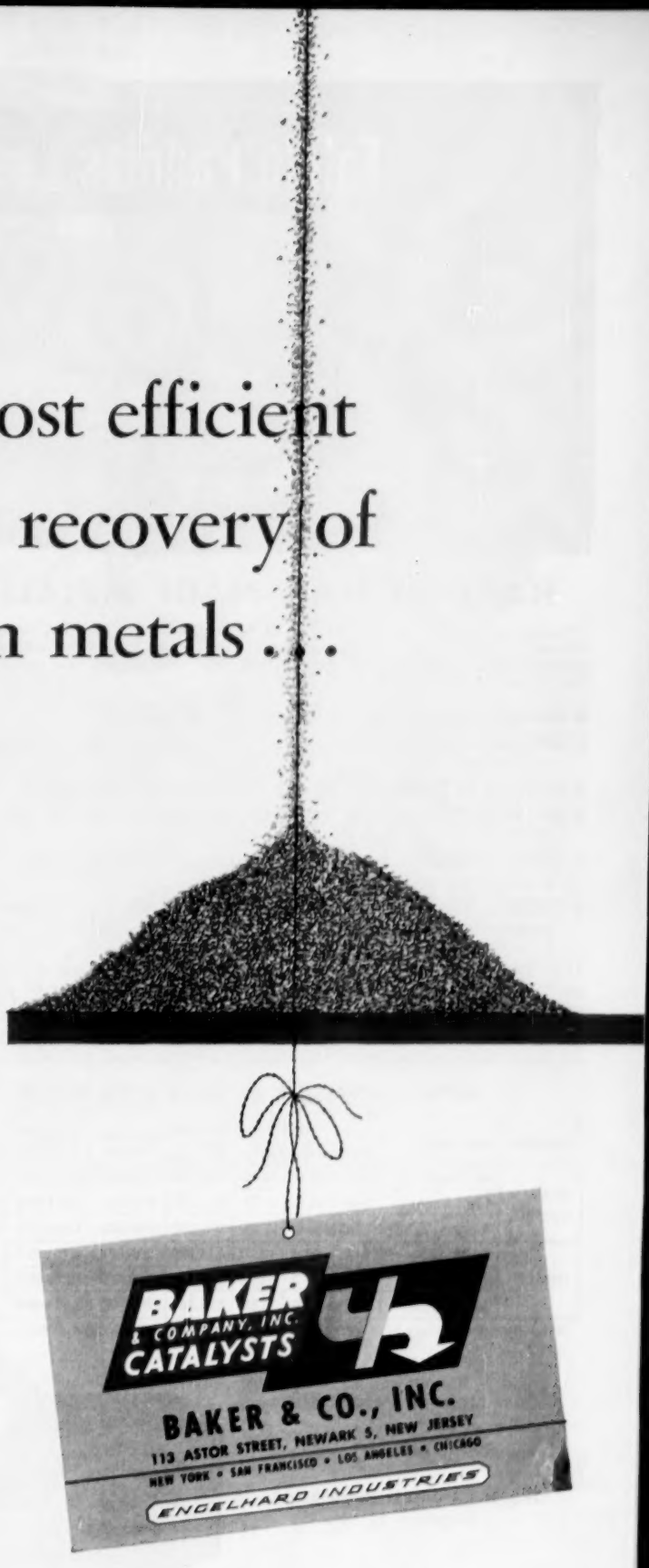
Here, specialized knowledge, experience and facilities combine to provide the chemical industry with a most efficient service for maximum recovery of platinum metals from spent catalyst.

Baker procedures recover and deliver 100% of assayed platinum metal content. Plants, personnel and equipment are geared for prompt recovery.

Baker plants are also prepared of course to manufacture platinum metals catalyst in any required concentration of metal, in the form and on the carrier best suited to your production.

Thus, to maintain an efficient, uninterrupted cycle of use, recovery and re-use—*place the problem with Baker & Co.* Detailed information is available upon request. Do call us.

All data of confidential nature are of course treated accordingly.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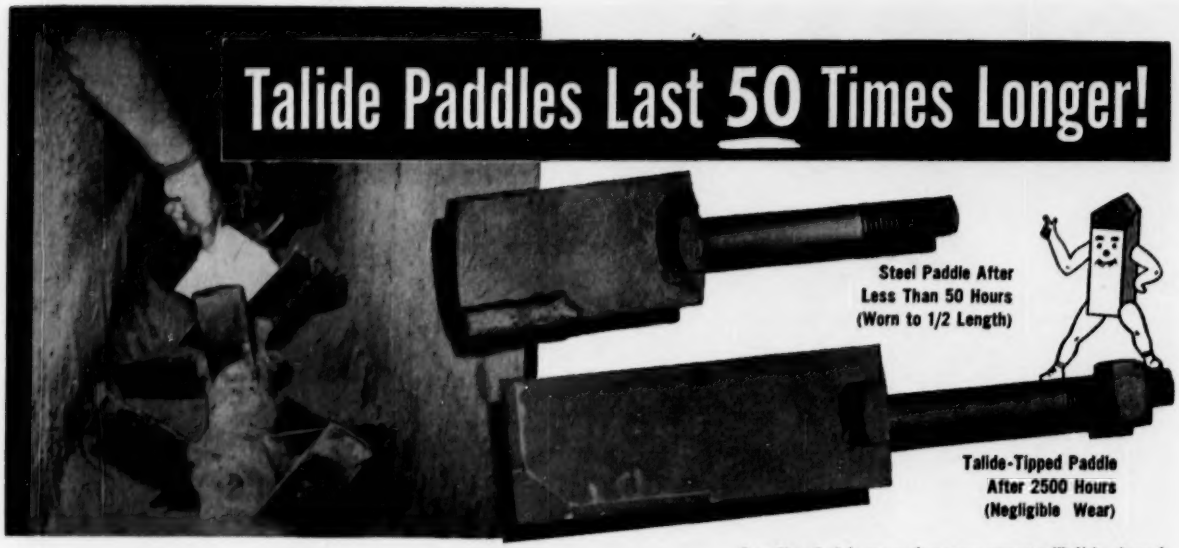
THE WORLD'S LARGEST WORKERS AND REFINERS OF PRECIOUS METALS

Talide Paddles Last 50 Times Longer!



HARDEST MAN-MADE METAL!

TALIDE METAL, a tungsten carbide of superior quality, is harder, stronger, and more resistant to abrasion than any other metal. Properly applied, it gives superior service on applications where wear, heat, strain, and shock are destructive to other metals.

- **ABRASION RESISTANCE**— Up to 100 times that of steel.
- **COMPRESSIVE STRENGTH**— Higher than all melted, cast or forged metals and alloys.
- **RESISTANCE TO DEFORMATION**— 2 to 3 times greater than steel.
- **HEAT RESISTANCE**— Resists oxidation and thermal shock up to 1500° F.
- **THERMAL EXPANSION**— Less than half the rate of steel, "creep" is negligible.
- **FRICTIONAL RESISTANCE**— Lower than steel, non-galling, "slippery" properties higher.

ALL TALIDE METAL grades are made in latest type vacuum electric furnaces by precision methods under rigid control. A wide variety of shapes and sizes can be supplied—up to 25" in diameter, 100" in length, and 5000 pounds by weight. Parts can be supplied to any grit finish required down to one micro-inch. The physical properties of the most commonly used grades are listed below. Other grades are available for specialized applications.

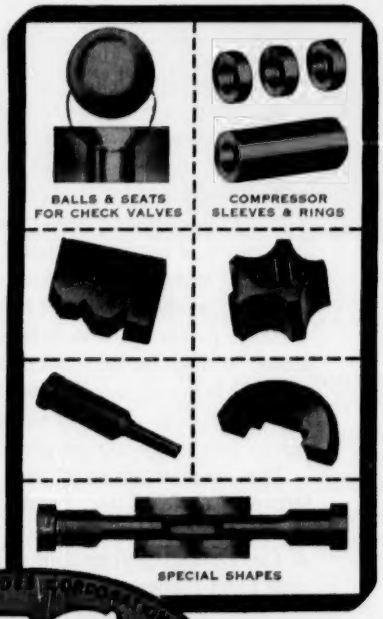
PHYSICAL PROPERTIES OF TALIDE METAL (P. S. I.)

Application	Operation	Talide Grade	Rockwell "A" Hardness	Specific Gravity (Density)	Transverse Rupture Strength	Compressive Strength	Co-Efficient of Thermal Expansion	Modulus of Elasticity (Deflection)
WEAR SURFACE	No Shock	C-91	91.8	14.90	235,000	710,000	3.00x10-6	91,000,000
	Light Shock	C-99	91.0	14.75	265,000	670,000	3.65x10-6	84,000,000
	Medium Shock	C-88	89.5	14.55	295,000	635,000	4.00x10-6	80,000,000
IMPACT	Light	C-85	88.4	14.25	315,000	600,000	3.75x10-6	77,000,000
	Medium	C-80	87.0	13.85	335,000	550,000	4.50x10-6	74,000,000
	Heavy	C-75	85.0	13.15	355,000	500,000	5.00x10-6	70,000,000

Note: Hardness values may vary plus or minus .2 to .3 on individual lots.

Leading brick manufacturer reports Talide-tipped pug mill paddles have outlasted 50 sets of hard-faced steel paddles to date—and are still in use. Operation involves mixing abrasive ceramic, clay and brick compositions.

TALIDE METAL is saving industry millions of dollars annually by wear-proofing vital parts on machine tools, presses, pumps, compressors and other types of processing equipment used in the steel, oil, chemical, plastic, auto, rubber, textile, glass, ceramic, mining and metalworking industry.



Send for new 76-page catalog 56-G or ask for sales engineer to call.

Metal Carbides Corporation
Youngstown 12, Ohio

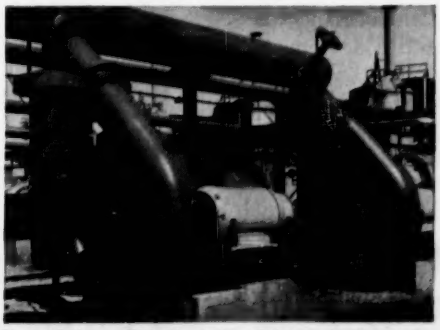
METAL CARBIDES CORPORATION
MC
TALIDE®
YOUNGSTOWN 12, OHIO
HOT PRESSED AND SINTERED CARBIDES • VACUUM METALS
HEAVY METAL • ALUMINUM OXIDE • HI-TEMP. ALLOYS
OVER 25 YEARS EXPERIENCE IN TUNGSTEN CARBIDE METALLURGY

CASING AND DIAPHRAGMS—heavy construction—split horizontally for easy accessibility
DIFFUSERS—streamlined for efficient gas handling
WELDED, CLOSED IMPELLERS—smooth continuous surfaces prevent "build-up" and resulting unbalance
SHAFT THRUST COLLAR—Kingsbury type thrust bearing to absorb load in either direction
LABYRINTH SEAL—prevents interstage leakage
EXTERNAL BEARINGS—preventing contact with gas handled

DEPENDABILITY

at the heart of
your refinery when

ELLIOTT CENTRIFUGAL COMPRESSORS are in service!



Two of three Elliott motor-driven single-stage centrifugal compressors serving oil black plants in Oklahoma. Each compressor is rated 5255 inlet cfm, handling air at atmospheric pressure and boosting it to 3.85 psig.

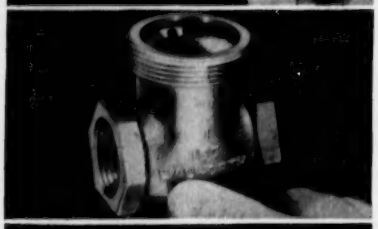
Elliott centrifugal compressors are designed and built with the simplicity and ruggedness that pays off in *dependable,* long-term, non-stop performance. Available in single and multistage types . . . for inlet capacities up to 150,000 cfm and pressures up to about 500 psig equivalent air pressure . . . turbine or motor driven . . . with or without step-up gear. For further details, call your nearby Elliott District Office or write Elliott Company, Compressor Department, Jeannette, Pa.

ELLIOTT Company

P7-9

Here's what makes Walworth Bronze Valves *the* real bargain!

TYPICAL OF WALWORTH QUALITY is the union body-to-bonnet connection which stiffens the body against internal pressure; makes taking the valve apart a simple operation and reduces the chances of distortion or leakage even though the valve is repeatedly taken apart and reassembled. With this type of construction there is no possibility of the bonnet coming off the valve while the handwheel is being turned.

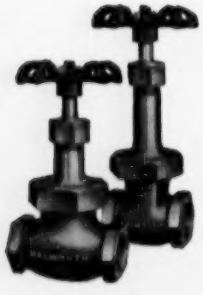


HEAVY BODY CONSTRUCTION is typical of *all* Walworth Bronze Valves. Extra-thick walls and rugged wrench hexes constitute a high safety factor and prevent distortion while the valve is being installed in the pipeline. Extra-deep pipe threads are accurately machined to eliminate leakage. Walworth Bronze Valves are also available with flanged, silver-brazed or soldered ends in certain sizes and types.

EXTRA-LARGE STEMS with extra-long, extra-deep threads prolong valve life, protect against wear and distortion and provide tight positive shutoff. The surface of the stem is machined to a glass-like finish for minimum handwheel effort and to preserve the packing which results in fewer inspections and less maintenance. The top of the stem is tapered and squared to hold the handwheel securely.

TO REDUCE WIRE DRAWING to a minimum, certain types of bronze globe valves have stainless-steel plug-type seats and discs heat-treated to a nominal hardness of 500 Brinell, adding years to valve life even in severe services. These valves can be tightly closed on sand, grit or pipe scale without damage. Seats and discs are machined simultaneously, assuring perfect mating.

There is a Walworth Bronze Gate, Globe, Angle or Check Valve for every service. Walworth is continually developing new valve types and materials, including plastics, to keep pace with the growing variety and severity of services in modern industry. For full information, see your Walworth Distributor or write: *Walworth, 60 East 42nd Street, New York 17, N.Y.*



WALWORTH

Bronze Valves and Fittings

YUBA ENGINEERED HEAT EXCHANGERS

Complete facilities for the production of the finest heat exchangers are at your service at Yuba. With branch offices and representatives at every principal point throughout the country, Yuba is able to have a sales-engineer at your desk in a matter of hours to help you start your heat exchanger project.

At three of Yuba's plants at Honesdale, Pa., Buffalo, N. Y., and Richmond, Calif., are top heat exchanger engineers with national reputations for their progressive designs. Daily they design all types of heat exchangers, large or small, simple or complex... heat exchangers which operate at vacuum or to pressures of 5000 psi, at temperatures below zero or to 1000 F and higher . . . heat exchangers made of all kinds of metals: carbon steel, alloy steel, aluminum, nickel, and non-ferrous alloys such as the new silicon bronzes... heat exchangers with bundles having a few tubes or as many as 7500, with heat transfer surfaces up to 15,000 and 20,000 sq. ft.

Yuba is experienced... some of its divisions having made heat exchangers for as long as 50 years. Yuba has outstanding techniques... many of its heat exchangers having been "firsts" in their fields. Yuba is nationally recognized... in the chemical, oil, gas, power, mechanical and heating industries.

Buy Yuba. Its plants in both the East and the West mean convenience for you, speedy delivery, service . . . but, above all, well-engineered heat exchangers tailor-made for your own process.

YUBA

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CONSOLIDATED INDUSTRIES, INC. Executive Offices: 351 California St., San Francisco 4, Cal. • New York Sales Office: 530 Fifth Avenue
Branch Offices and Representatives in Principal Cities

Chemically inert fittings, too

Made with standard 125# and 150# ASA housings (short radius), these 45° and 90° elbows can be installed in all standard flange piping systems.

Fluoroflex-T lining extends over the full gasket face of flange thus providing chemically inert, one-piece continuous barrier against all corrosive fluids.

Fluoroflex-T type S pipe and fittings are available in 1", 1½", 2", 3", 4" and 6" sizes.

FLUOROFLEX-T IS TEFLON AT ITS BEST

It's a known fact that properties of Teflon can be changed manyfold by deliberate or accidental minor variations of processing methods. The fabricator's *experience*, therefore, is the user's best assurance of quality and performance.

VISIT OUR BOOTH 889-891 AT N. Y. CHEMICAL SHOW.

universally corrosion-PROOF piping ...with strength of steel

Here is a chemically inert piping system that now means substantial savings for plants where severe corrosion is a costly downtime problem . . . and thermal shock an ever-present hazard.

NO CORROSION — EVEN AT HIGH TEMPERATURE AND PRESSURE

Lined with a patented high density compound of Teflon, Fluoroflex-T type S Pipe can handle virtually every known corrosive substance to 500°F. It will not contaminate the fluids handled.

The Fluoroflex-T liner is formed *over the full gasket face of the flange*, eliminating troublesome joints with built-in protection and sealing that requires no extra gasket. It is housed within schedule 40 seamless steel pipe with 150# ASA flanges. 300# ASA flanges also available.

ACTUAL SERVICE REPORTS: Replacing glass lined steel pipe for handling 20% hydrochloric acid at 248°F and 20 psi, pipe lined with Teflon resin was still in use 34 months later.

Lined pipe replaced silver lined pipe for handling acidic stream of boron trifluoride hydrochloric acid and organic acid at 347°F, 18 psi . . . was unchanged after 5 months.

Write for data and nearest distributor.

Fluoroflex-T completely covers full gasket face of flange . . . making integral gasket and liner absolutely immune to:

- **All acids including hydrofluoric, hydrochloric, sulphuric, aqua regia**
- **all caustics**
- **all chlorides inorganic and organic**
- **all sulphates**
- **all solvents**
- **all phenols**
- **all bleaching solutions**
- **all peroxides**

all hot . . . and at all concentrations

® Fluoroflex is a Resistoflex trademark, reg., U.S. Of. ® Teflon is a DuPont trademark.

Originators of high temperature fluorocarbon hose assemblies

Resistoflex
CORPORATION

Roseland, New Jersey · Western Plant: Burbank, Calif. · Southwestern Plant: Dallas, Tex.

Sprout-Waldron

gives you the Big Plus in MIXERS

Here's one of the largest ribbon-type mixers ever built—a Sprout-Waldron Horizontal Batch Mixer, Style "B". It is ideal for the rapid, intimate mixing of small percentages of a number of critical ingredients with a large bulk of basic material or filler.

Sprout-Waldron also offers the greatest variety of vertical mixers—ranging in size from the world's largest to the world's smallest. They offer big savings in power and space.

Other mixers in the Sprout-Waldron line include machines that convey as well as mix . . . that blend materials to a degree far beyond ordinary mixing . . . that raise and lower temperatures while mixing . . . and that dry damp materials and add liquids to dry materials while mixing.

You get more than a mixer at Sprout-Waldron. You also get reliable guidance, practical suggestions, and new ideas on installations and applications . . . at no extra cost. These are BIG PLUS factors that give you installations without bottlenecks, cut your costs, and help improve the uniformity and quality of your products.

For details, write for free Bulletin 95—an informative treatise on equipment and systems for processing dry and semi-dry materials.

SPROUT-WALDRON

Manufacturing Engineers Since 1866

15 LOGAN ST., MUNCY, PA.

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FROM START TO FINISH, YOU CAN DEPEND ON SPROUT-WALDRON

Acids and acid industrial atmospheres will ruin some insulations . . .

FOAMGLAS®

INSULATION

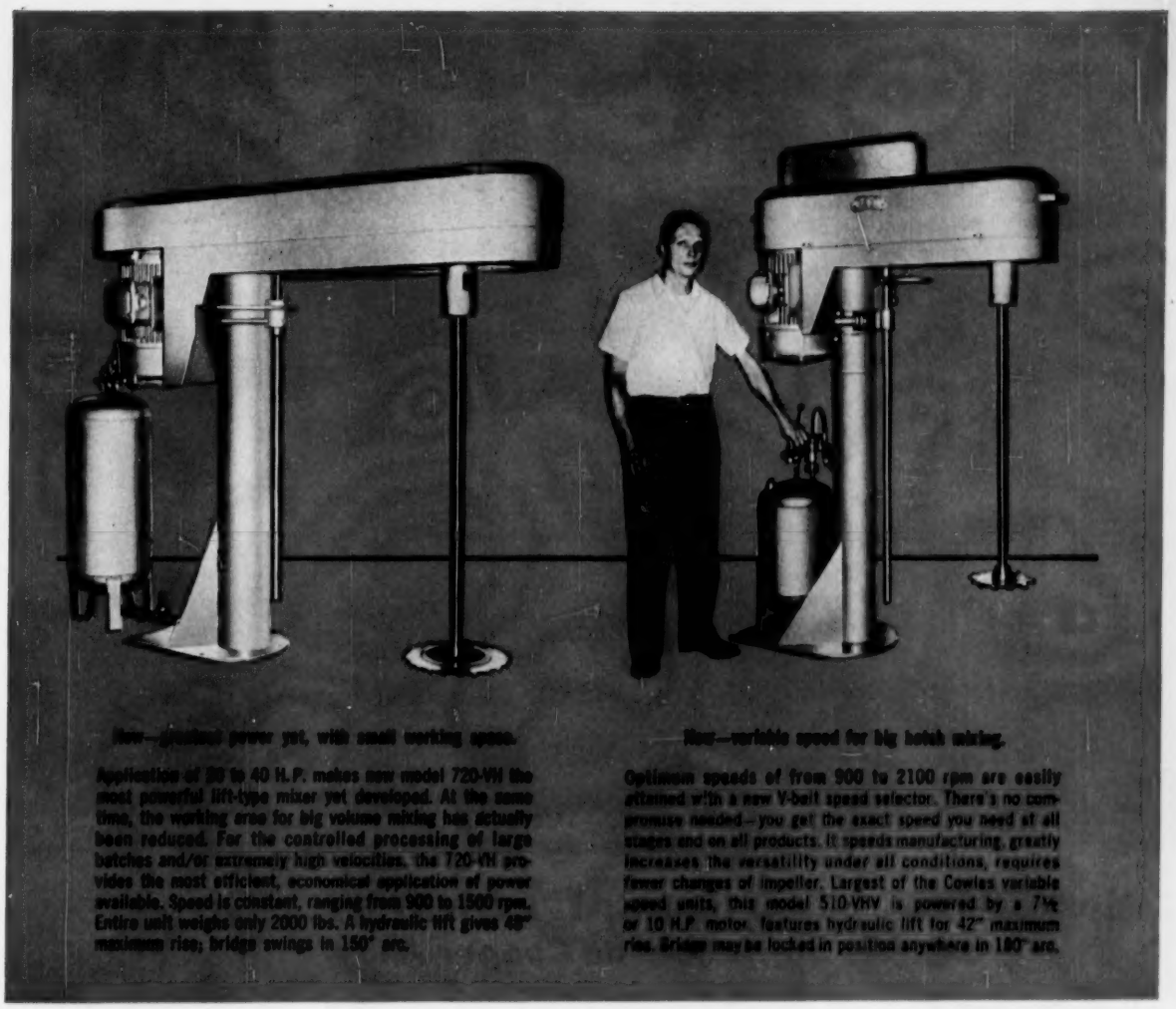
is acid-proof!

—like any true glass, FOAMGLAS is not attacked by common acids and acid fumes. And inorganic FOAMGLAS is the only thermal insulation which combines all these additional performance benefits in one material: it is waterproof and vapor-proof . . . incombustible . . . has remarkable compressive strength . . . is easy, economical to handle and install. Write today for detailed literature.

Pittsburgh Corning Corporation

Dept. **H-127,** One Gateway Center, Pittsburgh 22, Pa.

In Canada: 57 Bloor Street West, Toronto, Ontario



New—greatest power yet, with small working space.

Application of 30 to 40 H.P. makes new model 720-VH the most powerful lift-type mixer yet developed. At the same time, the working area for big volume mixing has actually been reduced. For the controlled processing of large batches and/or extremely high velocities, the 720-VH provides the most efficient, economical application of power available. Speed is constant, ranging from 900 to 1500 rpm. Entire unit weighs only 2000 lbs. A hydraulic lift gives 48" maximum rise; bridge swings in 150° arc.

New—variable speed for big batch mixing.

Optimum speeds of from 900 to 2100 rpm are easily attained with a new V-belt speed selector. There's no compromise needed—you get the exact speed you need at all stages and on all products. It speeds manufacturing, greatly increases the versatility under all conditions, requires fewer changes of impeller. Largest of the Cowles variable speed units, this model 510-VHV is powered by a 7½ or 10 H.P. motor, features hydraulic lift for 42" maximum rise. Bridge may be locked in position anywhere in 180° arc.

Cowles develops two new multi-phase* mixers for faster big-volume production

***What is Cowles "multi-phase" mixing?**

Cowles exclusive mixing principle is based on the unique action of the patented Cowles Impeller. Where ordinary mixers do a partial job by imparting random motion to particles in suspension, the Cowles takes material through several extra phases: Material is thrown off at 60 mph speed from impeller vanes. This creates violent action of the suspension against itself—a zone of "hydraulic attrition" in which particle is sheared and smashed against particle to accomplish truly ultimate dispersion. Direct action of the impeller is thus multiplied many times. At the same time, the entire batch is kept in "total motion", returning to the impeller in a controlled cycle. Result is a speed, thoroughness and predictability unmatched by other methods. Scientific details on request.

THE COWLES PRODUCTION RECORDS of up to 20 times faster ultimate dispersion have brought the inevitable result: user demands for ever larger and more versatile units. And here are the Cowles answers. They are proved for up to 2½ times the per-hour volume you may be used to. On any liquid-base mixing, dispersing, deagglomerating, homogenizing or emulsifying job, the Cowles promises not only greater speed and simplicity, but lower space, power and maintenance requirements.

The Cowles enjoys the fastest growing popularity in its field.

To find out how the most modern mixing methods can benefit your operation, let us prove the Cowles in your plant—at our risk! Write today on your letterhead for complete details.

MOREHOUSE COWLES

5716

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Representatives in principal cities
Convenient lease and time payment plans

JACK B. RINCKHOFF (right), Chief Engineer, Sulphuric Acid & Phosphates Dept., Chemical Construction Corp., N. Y. City. Left, Michael De Piano, New York Cooper Alloy Representative.

RINCKHOFF OF CHEMICAL CONSTRUCTION

answers 3 questions on Cooper Alloy Valves

Q. Mr. Rinckhoff, in specifying equipment for the H_2SO_4 plants that Chemico constructs around the world, what Cooper Alloy valve models do you buy most of?

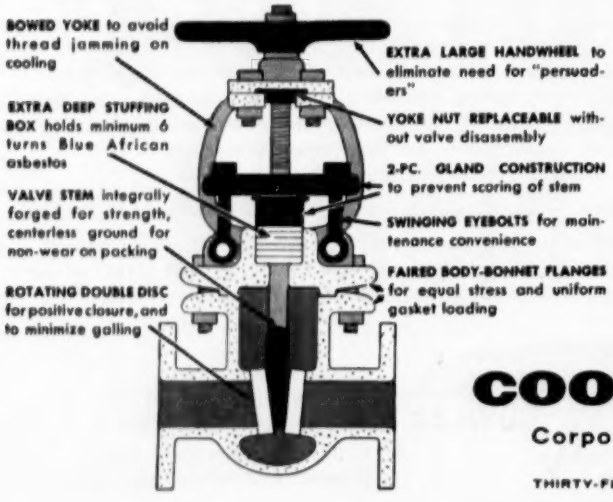
A. Over 80%, I'd say, are OS&Y type gate valves, in sizes 1" to 8"

Q. What's your most important reason for buying Cooper Alloy valves?

A. Availability. Your chain of distributors across the country and in remote parts of the world is of great importance to us. In foreign construction we have often specified Cooper Alloy because of this all-important availability.

Q. What about design and quality?

A. Vital. Valve design determines performance, and our specifications are rigid. As a construction company, we can't afford to jeopardize our reputation by installing questionable equipment. Cooper Alloy valves have passed our tough specs, and have my approval for all severe construction applications.


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
SWINGING EYEBOLTS for maintenance convenience
PAIRED BODY-BONNET FLANGES for equal stress and uniform gasket loading

A VALVE DESIGNED FOR STAINLESS!

The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

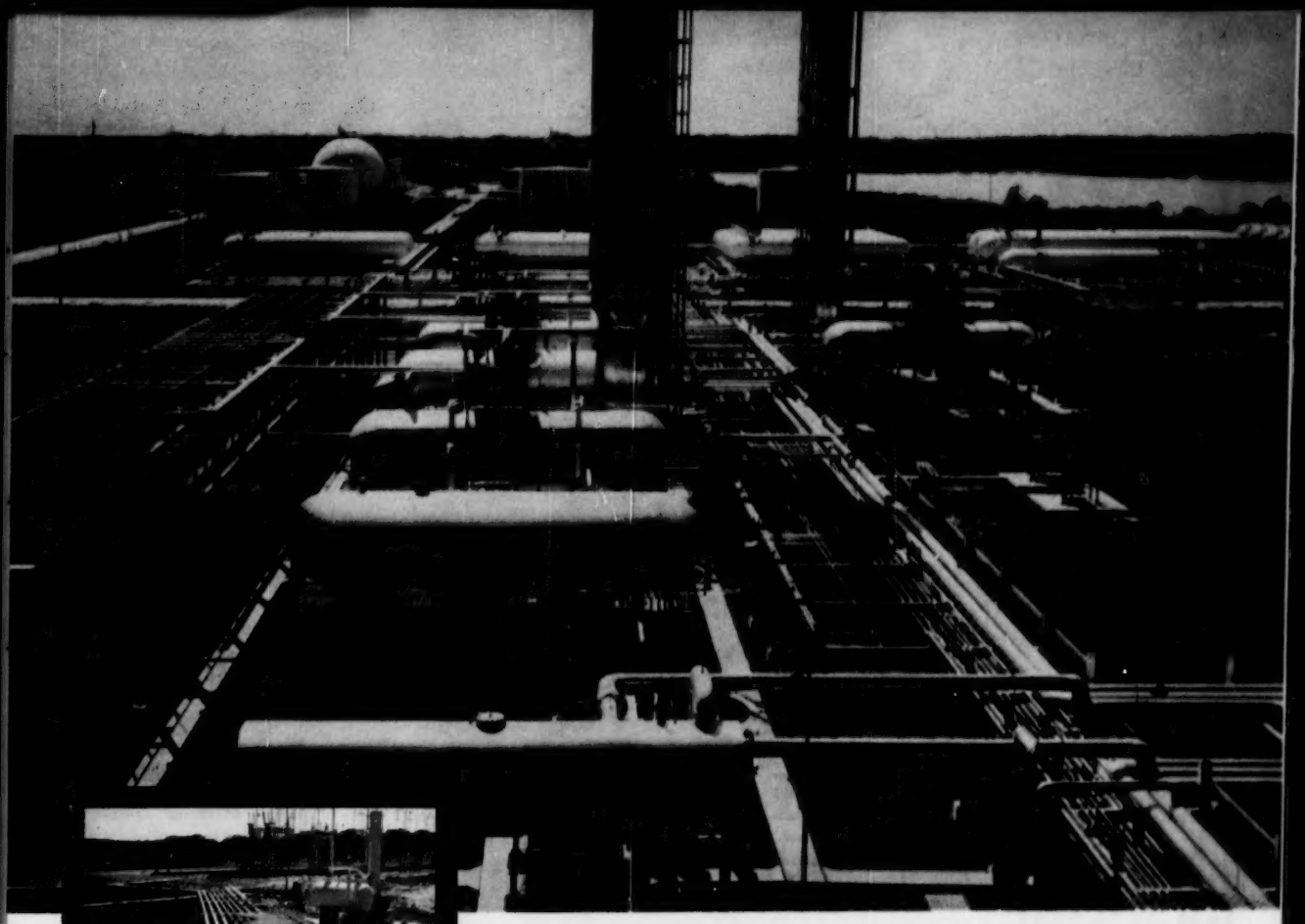
As the little CA man below is saying: *"You can tell a Cooper Alloy Valve as far as you can see it!"* Write today for *your* copy of our folder "Design Factors In Stainless Steel Valves." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

COOPER ALLOY

Corporation • Hillside, New Jersey

VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING



Three-coat systems of Normal Copon self-cleaning white tank coating and three-coat systems of Normal Copon aluminum tank finish were used to protect this fractionating plant of The Bay Petroleum Corp. (a subsidiary of Tennessee Gas Transmission Co.).

Copon pipe coatings provide thicker films per coat for extra protection of seams, welds, sharp edges and other trouble spots.

Copon tank coatings remain tough and elastic when subjected to heat, high humidity and chemical fumes.

tanks stay whiter, brighter... protected by Copon coatings

Coatings of Normal Copon provide superior protection for tanks, pipes, and miscellaneous plant equipment. They cling tenaciously to metal surfaces, withstand the expansion and contraction of metal, and provide longer-lasting film integrity to assure permanent corrosion protection. Expensive surface preparation is not required when Copon-protected tanks are repainted, and Copon Coatings have the slowest rate of erosion in the industry.

Copon®

FOR CORROSION CONTROL

For complete information on Copon, write on your company letterhead to the manufacturer located nearest your city.

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65 W. First South St., Salt Lake City 10, Utah

WALTER N. BOYSEN CO.
42nd & Linden Sts., Oakland 8, Calif.
2309 E. 15th St., Los Angeles, Calif.

BRITISH AMERICA PAINT CO., LTD.
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BROOKLYN PAINT & VARNISH CO., INC.
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COAST PAINT & LACQUER CO.
P. O. Box 1113, Houston 1, Texas

ENTERPRISE PAINT MANUFACTURING CO.
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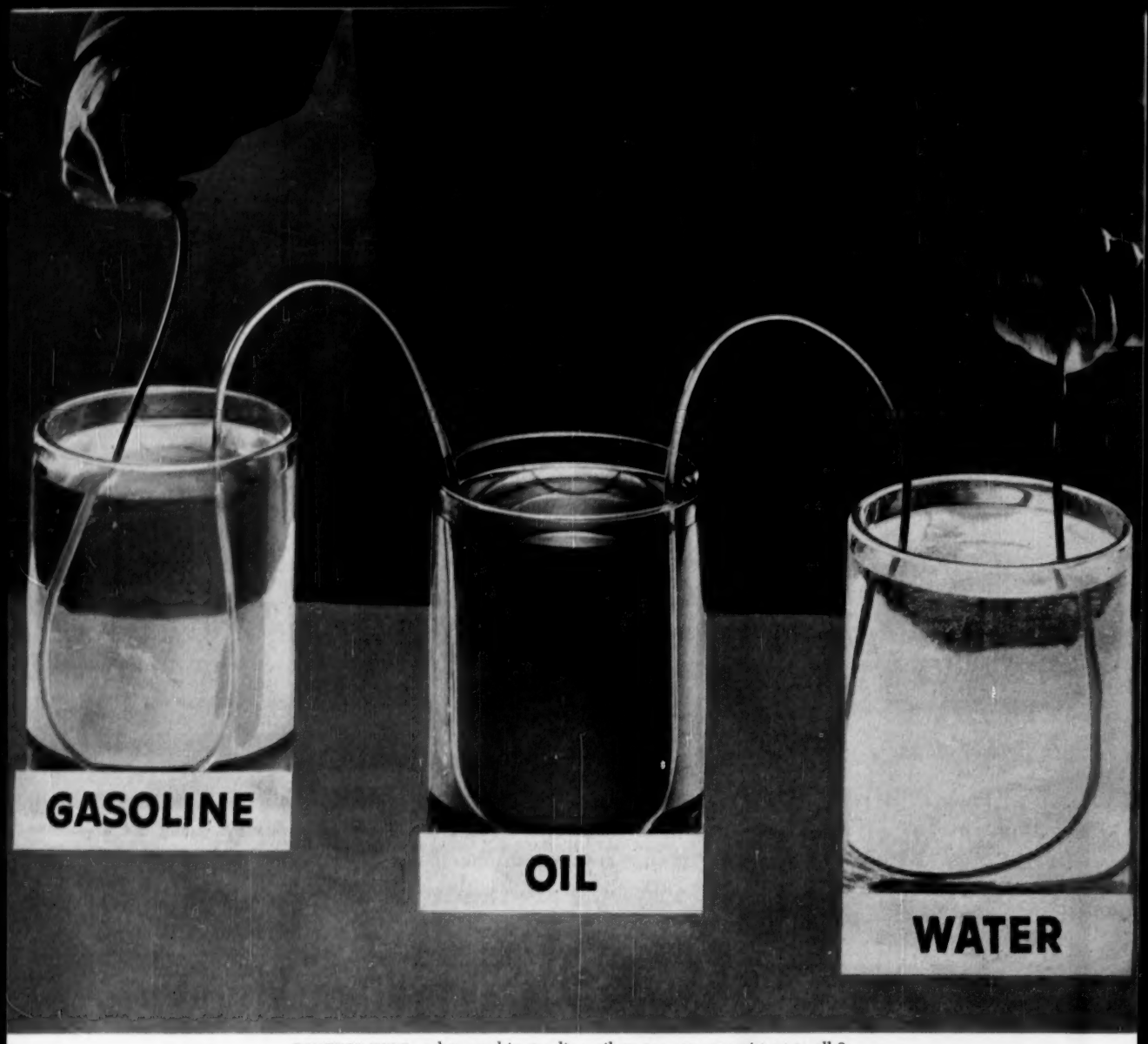
INDUSTRIAL PAINT MANUFACTURING CO.
P. O. Box 2371, Birmingham 1, Alabama

KOHLER-McLISTER PAINT CO.
P. O. Box 546, Denver 1, Colo.

McDOUGALL-BUTLER CO., INC.
2929 Main St., Buffalo 14, New York

JAMES B. SIPE and COMPANY, INC.
P. O. Box 8010, Pittsburgh 16, Pa.

COAST PAINT & LACQUER De MEXICO, S.A.
Apartado Postal No. 9637, Mexico, D.F.



DENTROL WIRE—submerged in gasoline, oil, water—proves resistant to all 3.

New Dentrol thermoplastic wire RESISTS ALL 3—GASOLINE, OIL, WATER!

Dentrol wire affords *new safety* wherever wiring is exposed to gasoline or oil—*new economy* over the lead-covered cable you're now using in these areas.

Made with a clear nylon jacket over-all, Dentrol not only beats gasoline, oil and moisture—but is exceptionally resistant to abrasion. It is easily installed (hard, smooth finish makes pulling through conduit simple), easily stripped, lightweight for easy handling.

Suggested uses: for 600 volt wiring for lighting, power and control in and around service stations, refineries, tank farms, and industrial plants.

Dentrol is Underwriters' Laboratories approved as TW and "gasoline-resistant" wire for use in open raceways where exposed to gasoline or gasoline vapors. Thus it meets the provisions of section 5023 of the 1956 National Electrical Code, concerned with installations in hazardous locations.

Available in colors, and in 500′ cartons. See your Anaconda distributor. For information write: Anaconda Wire & Cable Company, 25 Broadway, N. Y. 4, N. Y. 57394 Rev.

LIVE BETTER ELECTRICALLY

SEE THE MAN FROM **ANACONDA®**
FOR **DENTROL WIRE**

WHEN YOU'RE IN A SQUEEZE FOR A PUMP

LOOK HERE

FOR FAST ACTION

SEND THE COUPON TODAY FOR THIS CATALOG OF

B&G STOCK PUMPS

Why take a production loss because of a pump breakdown? B&G *maintains a factory stock of the most commonly used sizes of centrifugal pumps for immediate delivery!* Base-mounted and integral-motor pumps as listed in B&G Stock Pump Catalog are available in capacities to 325 GPM, heads to 140 ft.

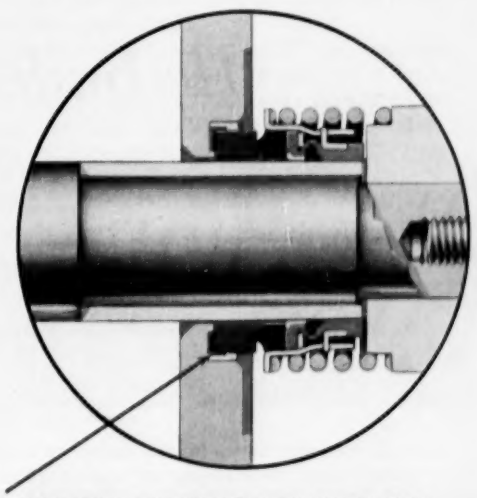
Your local distributor or B&G Representative will be glad to assist in selecting the proper pump for your needs. Or, write, wire or phone the Bell & Gossett factory at Morton Grove, Illinois. In any case, you'll get fast action.

B&G SERIES 1522, 1531 AND 1510 STOCK PUMPS ARE DISTINGUISHED BY VERTICAL SPLIT-CASE DESIGN...NON-OVERLOADING MOTORS...BRONZE FITTED CONSTRUCTION...LEAK-PROOF "REMITE" MECHANICAL SEAL

Why B&G Centrifugal Pumps give years of trouble-free performance is evident from their design features.

Vertical split-case construction permits removal of the bearing bracket without disconnecting pipe lines or motor leads. Solid cast iron volute—with support feet in larger sizes—prevents transmission of piping strains.

The shafts are made of special alloy steel, super-finished and oversized to keep deflection at a minimum. In Series 1522 and 1510 Pumps oil lubrication affords continuous protection to the heavy duty bearings. Leak-proof operation is assured by the "Remite"* Mechanical Seal—an exclusive B&G development.



***LEAK-PROOF "REMITE"® MECHANICAL SEAL**

This latest advance in B&G pump engineering features a floating seat of "Remite"...a new material developed after years of laboratory experimentation. "Remite" is so hard it will cut glass or steel—eliminates packing rings and gland adjustment. Seal is self-lubricating.

BELL & GOSSETT
COMPANY
Dept. FB-14, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive Toronto 16, Ontario

BELL & GOSSETT CO., Dept. FB-14, Morton Grove, Ill.
Please send a copy of the B&G Stock Pump Catalog CSP-257A.

Name.....

Address.....

City.....*Zone*.....*State*.....

He Builds with SWECO

When this oil man needed a new refinery he faced a basic question: *How to get the best design and construction at lowest capital investment?* SWECO's answer made him a life-long client.

To build a new refinery for his supply of crude, he investigated many engineering and construction companies. One, he found, was just the right size: Not so big that his medium-size installation would get lost behind vast projects. But big enough to provide complete service. The picture was perfect: personal attention from a seasoned staff.

He investigated SWECO

SWECO engineering teams had designed and built complete refineries and refinery additions all over the world. They were licensed to engineer and construct plants for most modern refining processes. SWECO jobs, he found, were brought in on-target – regardless of location, weather, untrained labor or earth-girdling supply lines. And SWECO's reputation in the design and manufacture of petroleum processing equipment meant valuable knowledge and control of sources of supply.

He invited SWECO's proposal

Ingenuity and know-how were evident in every page of the SWECO proposal. It included field surveys and soil tests. Economic analyses and market studies. A provisional flow sheet showed the entire process graphically. Specifications, schedules, and plans were spelled out in detail. The proposal was wrapped up with a complete feasibility report.

He turned the job over to SWECO

From engineering and design, through purchasing and expediting, field construction – even through training personnel and putting the plant into operation–the SWECO engineering team took full responsibilty. It was a typical SWECO job: on-stream on-schedule. Now, the oil man is a typical SWECO client. Whatever his engineering and construction needs – complete plants or additional units for an existing installation – he builds with SWECO.

For the story on what SWECO Engineering and Construction teams can do for you in building refineries or petro-chemical plants . . . write for Bulletin E-7-32.

SWECO

Southwestern Engineering Company

4800 Santa Fe Avenue • Los Angeles 58, California

Engineers and Constructors . . . Manufacturers

CORROSION RESISTANT... NO PAINTING WITH ALCOA RIGID CONDUIT

If you have motors, controllers, switchgear and other electrical equipment in damp or corrosive locations, Alcoa® Aluminum Electrical Rigid Conduit can serve you better than any other material.

Because it resists corrosion, it never needs maintenance painting. It is nonsparking. It has Underwriters' Laboratories approval.

But there are other advantages, too . . .

It weighs about one-third that of steel. It's easier to cut, bend, thread, install. Factory-applied internal lubrication makes wire pulling easier and quicker.

It is nonmagnetic. You get up to 20% less voltage drop. Conductors can be separated, regardless of load.

It's surprisingly economical, too. Large sizes of Alcoa Conduit cost less than steel. When all factors such as maintenance and installation are considered, aluminum conduit in all sizes is competitive with steel.

Alcoa Aluminum Rigid Conduit is available throughout the country from warehouse stocks. Fittings, too, are readily obtainable, together with suitable Alcoa thread cutting and joint compounds.

Get the complete story from your nearby Alcoa sales office. Or use the coupon below to obtain literature and a generous sample of this better conduit.

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Pittsburgh 19, Pa.

Please send literature on *Alcoa Aluminum Electrical Rigid Conduit* and a one-foot sample.

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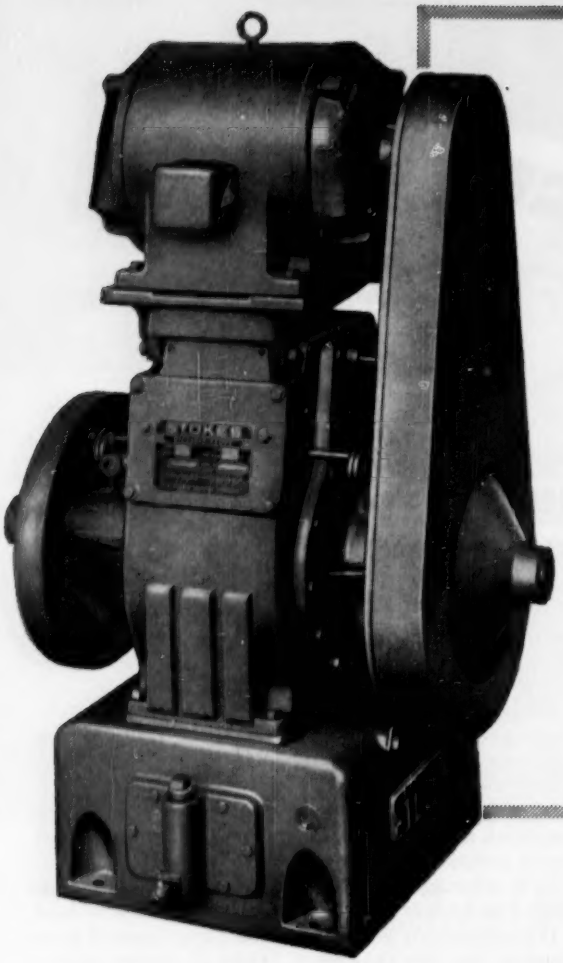


VERTICAL DESIGN

vacuum pump saves you floor space

If floor space for your vacuum system installation is a problem, here's an "assist" from Stokes. Special Stokes vertical design cuts floor space requirements. For example, the 130 cfm Model 212 Microvac measures less than 3 feet on a side . . . makes your entire set-up smaller.

And together with these features of compactness, you get a 15% increase in pumping capacity . . . at no increase in price. In this way, Stokes Microvac pumps measure up as the standard of comparison for reliable, low-cost performance.

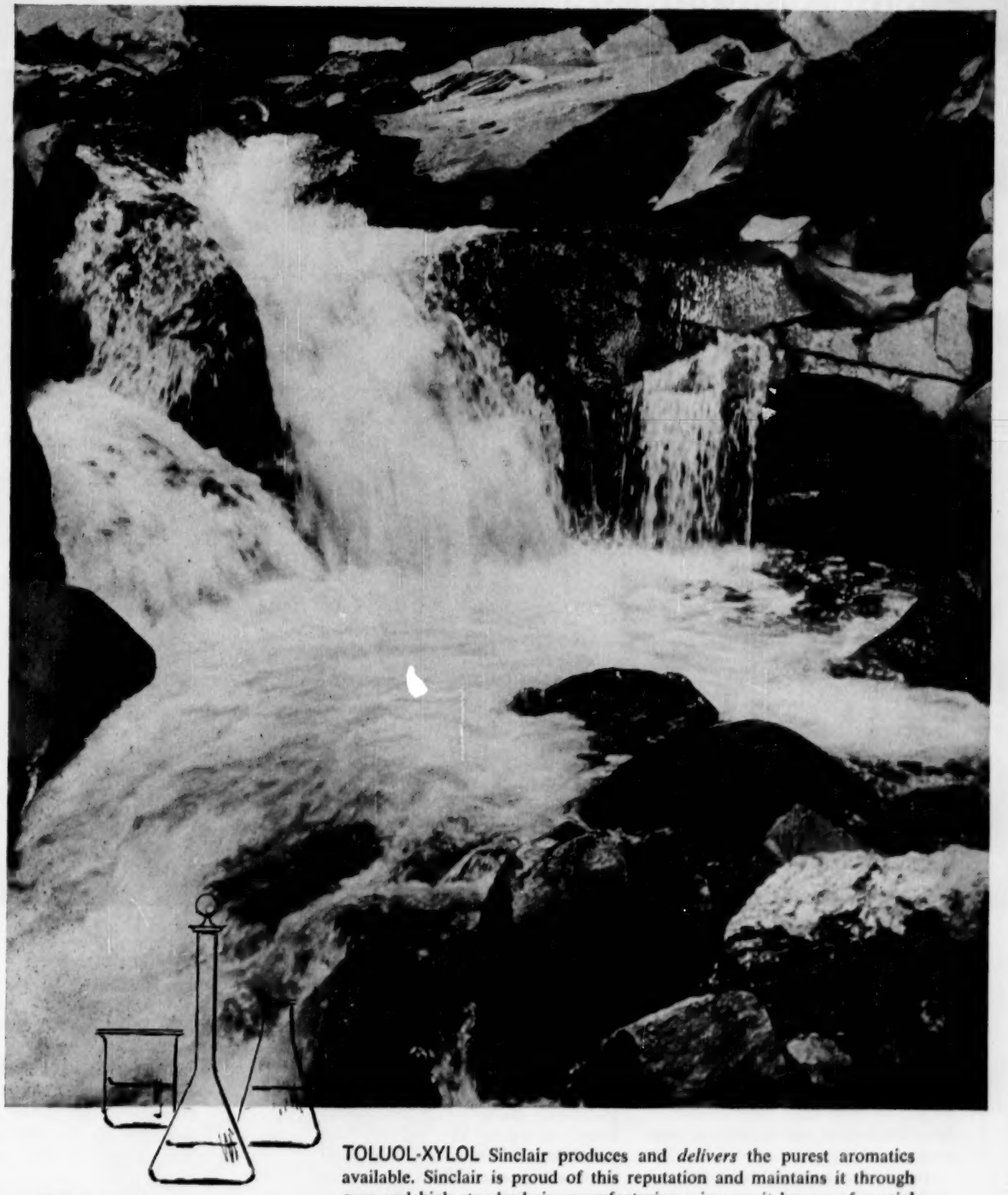
Here's what you get with the Microvac line:

- Minimum maintenance—mechanical face seal eliminates oil leakage at shaft. No stuffing boxes. Fully automatic lubrication.
- Wide pressure ranges—new exhaust valve design assures trouble-free operation during extended pumping periods, in the high pressure range.
- Dirt troubles prevented—intake screen filter traps dirt, scale and other damaging solids.
- Added protection—new oil filter in the line supplies extra protection to bearings and shaft seal.

Microvac pumps give you the high efficiency you want . . . used separately or as roughing pumps with diffusion or booster pumps. Write for catalog 752, "Stokes Microvac Pumps for High Vacuum"; Booklet 755, "How to Care for Your Vacuum Pump" . . . or call your nearest Stokes office to find out how we can help you solve your particular vacuum application problem.

Vacuum Equipment Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES



Purity

TOLUOL-XYLOL Sinclair produces and *delivers* the purest aromatics available. Sinclair is proud of this reputation and maintains it through care and high standards in manufacturing – insures it by use of special transportation equipment provided exclusively for aromatics.

If you use solvents in your formulations – get the highest in purity and uniformity. It costs no more. For complete information, call or write:

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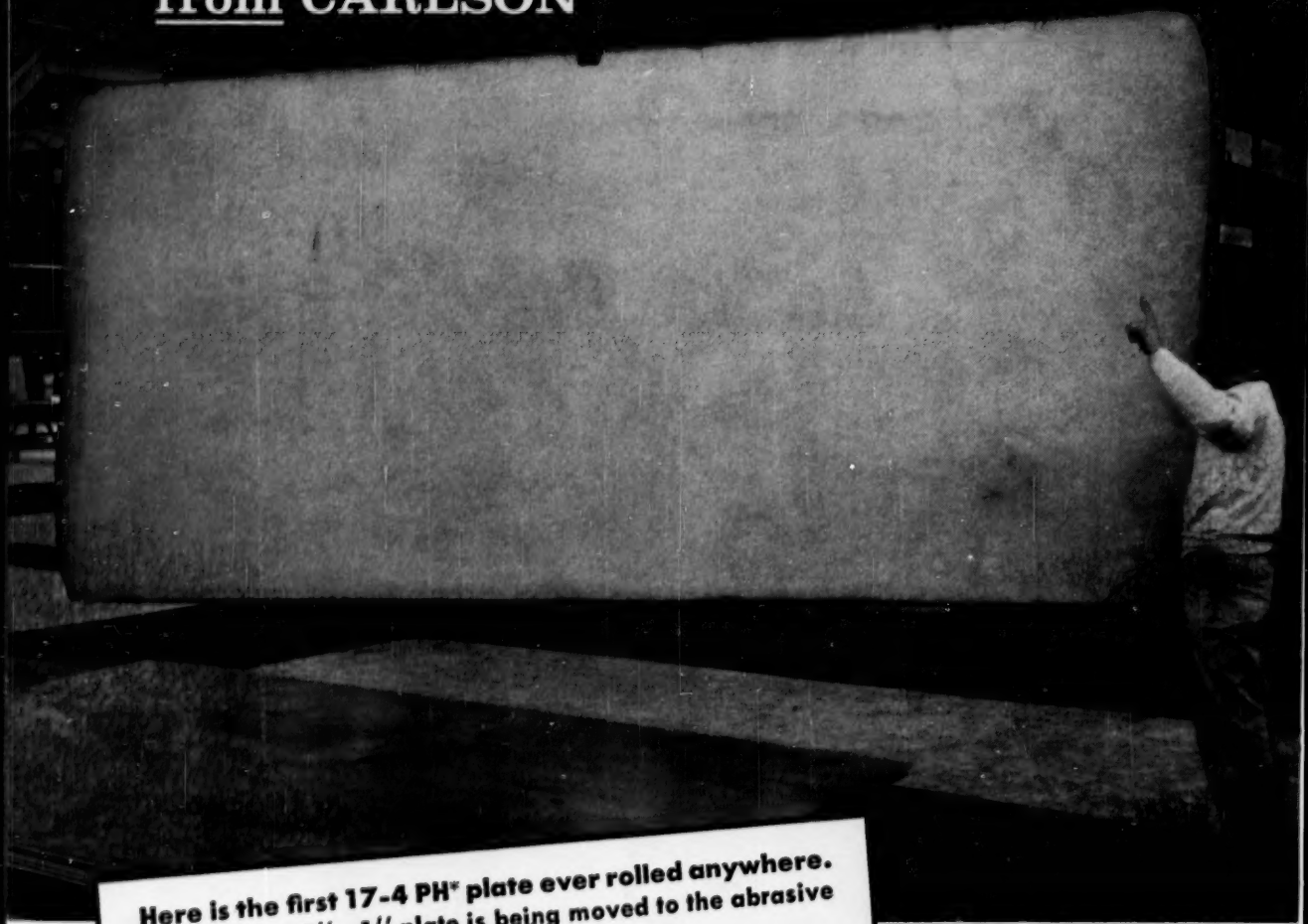
Now you can get both 17-4 PH* and 17-7 PH* stainless steel plate from CARLSON



Here is the first 17-4 PH* plate ever rolled anywhere. This 179" x 79" x 1" plate is being moved to the abrasive cutters for trimming to specified size.

You can build equipment with either of two precipitation-hardening stainless plate grades—17-4 PH* and 17-7 PH*. Both are available at Carlson—both can be cut to your exact specifications to save delays and true-up time in your own plant.

The Armco-developed 17-4 PH and 17-7 PH grades combine ease of fabrication, hardenability, high strength and corrosion resistance. These grades have the desirable mechanical properties of the hardenable chromium types and a workability and corrosion resistance approaching regular 18-8 stainless steels. Simplified low temperature heat treatments will produce a Rockwell hardness of C40 to C50. And tensile strengths range from 180,000 to 215,000 psi depending upon the heat treatment.

Take full advantage of our complete service in stainless steel plate and plate products. Write, wire or phone for detailed information on 17-4 PH and 17-7 PH stainless steels.

*Trade Mark of the ARMCO STEEL CORPORATION

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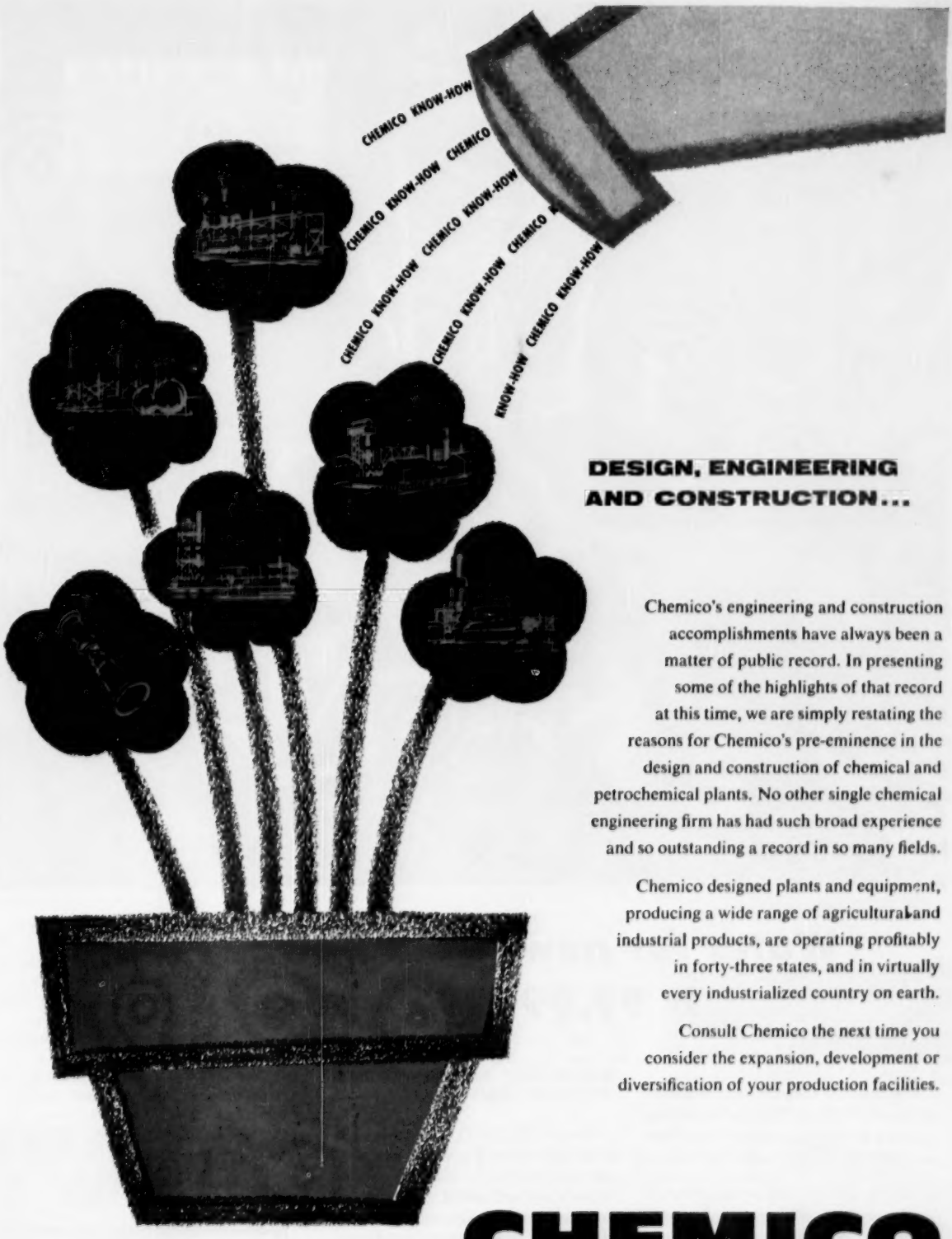

DESIGN, ENGINEERING AND CONSTRUCTION...

Chemico's engineering and construction accomplishments have always been a matter of public record. In presenting some of the highlights of that record at this time, we are simply restating the reasons for Chemico's pre-eminence in the design and construction of chemical and petrochemical plants. No other single chemical engineering firm has had such broad experience and so outstanding a record in so many fields.

Chemico designed plants and equipment, producing a wide range of agricultural and industrial products, are operating profitably in forty-three states, and in virtually every industrialized country on earth.

Consult Chemico the next time you consider the expansion, development or diversification of your production facilities.

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CHEMICAL CONSTRUCTION CORPORATION

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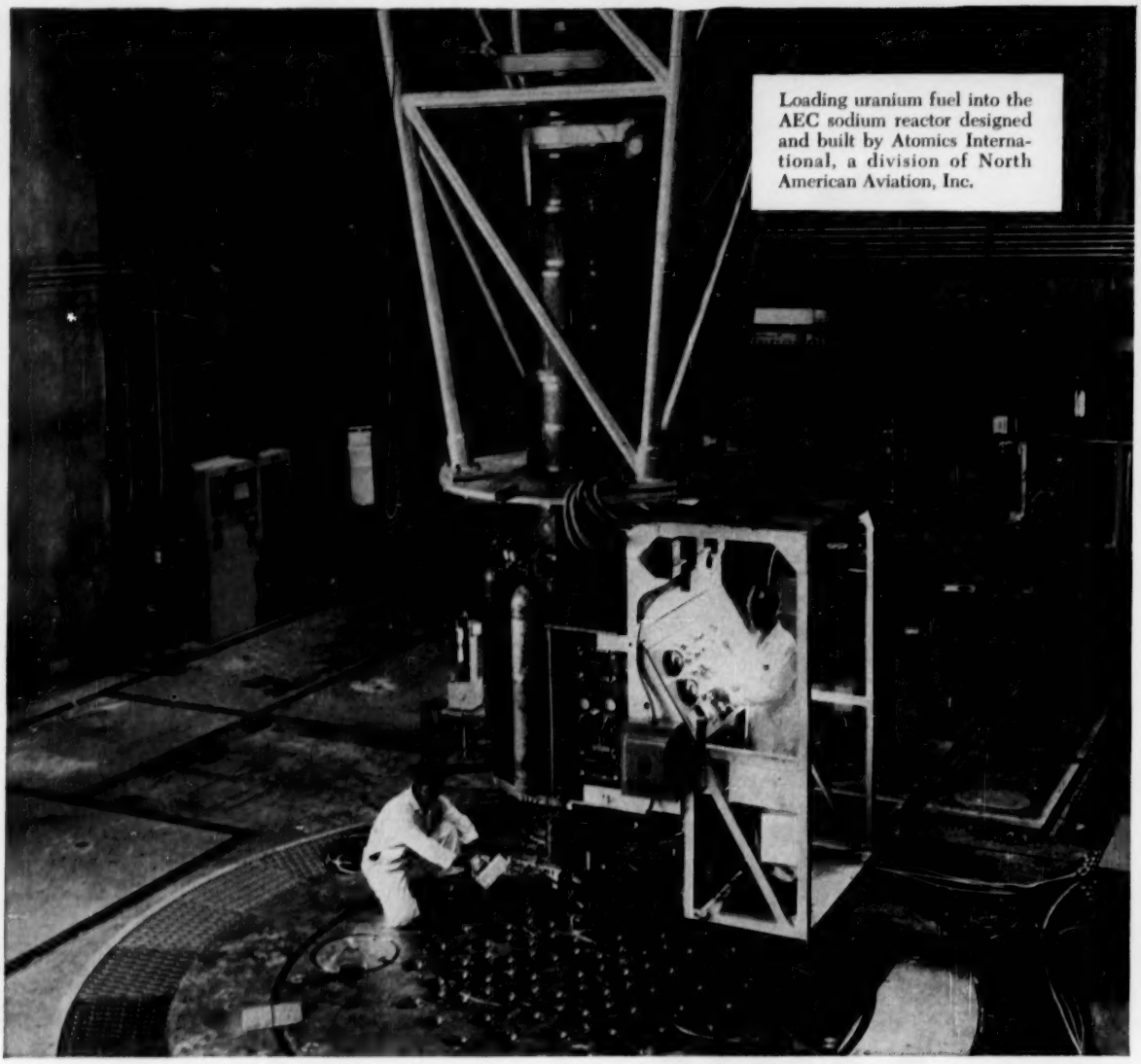

Loading uranium fuel into the AEC sodium reactor designed and built by Atomics International, a division of North American Aviation, Inc.

Water for new Atom Power Plant is 99.999992% pure!

● Southern California Edison Co. . . . now generating current from this new reactor in the Santa Susana Mountains . . . is the first private utility to produce electricity from a non-military reactor.

As in any system using water or steam in or near an atomic reactor, the quality of the water at the Santa Susana plant is important. Suspended and dissolved mineral solids must be removed to prevent them from depositing in boiler tubes and turbines. In other types of reactors, these solids can also pick up and carry radioactivity and could make turbines and other equipment difficult for maintenance or repair.

Although this plant's water supply is a clear well water, it contains almost 600 parts per million of hardness salts and other dissolved solids. The Permutit softener and demineralizer reduce these solids to 1/12 part per million . . . a purity of 99.999992%!

Permutit was chosen to design and supply this precise and critical equipment because of its long experience in water conditioning.

If your problem is Water . . . for industrial, municipal or home use, we'd like to discuss it with you. Address: The Permutit Company, Dept. CE-13, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ontario.

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A DIVISION OF PFAUDLER PERMUTIT INC.
Water Conditioning
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USING

DU PONT ELASTOMERS

in industry

Neoprene conveyor hauling petroleum coke shows little deterioration after 2 years' constant use

Seals of HYPALON in heat exchanger are undamaged by 125° F. aqua regia fumes

J. Bishop & Co. Platinum Works, which specializes in the field of refining precious metals, uses a new tube-type heat exchanger to condense aqua regia fumes for safe disposal. The cooler in this unit contains 1,275 Pyrex tubes each ⅜ in. diameter and 10 ft. long. Water circulated through the tubes condenses the aqua regia fumes which are passed through the cooling chamber.

Each tube has three annular seals made of HYPALON. These resilient stoppers permit thermal expansion, yet prevent aqua regia leakage; seal water out of the cooling chamber. Despite the corrosive atmosphere, the seals of HYPALON have been used for over 13 months without a failure.

HYPALON is especially suited for service where conditions are extreme. In addition to chemical resistance, this newest Du Pont synthetic rubber is completely resistant to ozone and highly resistant to heat, abrasion, weathering and flex cracking. Seals, gaskets, tank linings are but a few applications. Send coupon for more details.

Seals of HYPALON resist corrosive action of hot aqua regia. 3,825 seals are used in this heat exchanger.

Head end of the 2000-ft. neoprene coke conveyor. Coke is lifted from pit to belt for transfer to storage area.

Neoprene's resistance to heat, oil, abrasion, weather keeps belt operating despite 150-tons-per-hour beating

At Union Oil Company's Santa Maria, California, refinery, two huge twin coker drums are used to vaporize gasoline from heated crude oil. This high-temperature process leaves a hot residue—petroleum coke—which is salvaged and sold to make lampblack, electrodes and other products. After the gasoline is distilled, the coke is removed from the drums with water jets under 2000-lb. pressure, and dumped into a pit for draining. It is carried from the pit to a storage area on a 2000-ft. neoprene conveyor belt at a rate of 150 tons per hour.

Depending upon how soon it is transferred to the conveyor, the coke may be hot or cooled. It may be wet or dried out and dusty. When dry, it ranges in size from fines to large lumps.

This oily and abrasive punishment would quickly ruin ordinary rubber, yet the neoprene conveyor has been in use over 2 years and is still good as new. Neoprene rollers are also used in place of steel belt idlers because abrasive coke could wear out or foul the metal parts.

Neoprene's resistance to heat, weather, oils and abrasion as well as to sunlight and chemicals makes possible this good service record. Its balanced combination of properties offers many opportunities for savings wherever you need a durable, resilient material for belting, hose, gaskets and other applications. Mail the coupon below for complete information.

Neoprene belt stays resilient and serviceable despite constant exposure to sunlight.

DU PONT

***HYPALON** is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

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☐ Send me a free copy of *The Du Pont Elastomers* (a review of properties of neoprene and HYPALON).

☐ Add my name to the free mailing list of the *Elastomers Notebook* (contains articles based on uses of Du Pont elastomers in industry).

E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. CE-12
Wilmington 98, Delaware

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In carbon bisulfide production . . . Selas Gradiation® Heating assures Stauffer *longer* runs

It's the uniformity of Gradiation Heating . . . along and around the multiple coils . . . which helps Stauffer Chemical Company extend tube life and stay "on stream" for longer periods in continuous production of carbon bisulfide.

In this operation, corrosion rate is such a critical function of temperature, that small temperature variations soon manifest themselves as measurable differences in peripheral tube-wall thickness . . . and cause rapid tube deterioration.

Add Selas Zone Control; instant response to controller demand; operation at designed capacity from moment of start-up . . . and it is apparent why more and more chemical and petrochemical processors are choosing Selas Gradiation Heating . . . *designed and custom-built for their specific needs.*

Send for Bulletin 1012, "Gradiation Heating for Petroleum and Chemical Processing."
Selas engineers will be glad to discuss your heat-processing requirements with you.

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DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers
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Roll It Anywhere for Fast High-Pressure Service!

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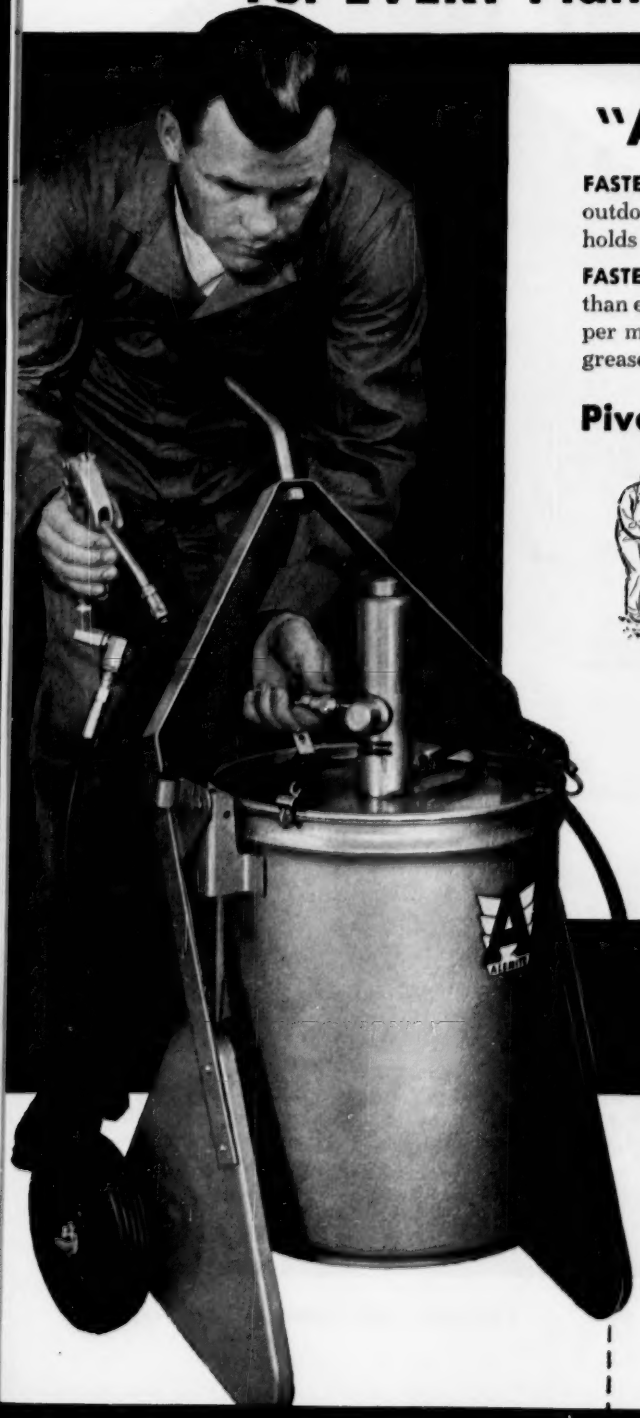
For EVERY Plant Lubrication Job!



"AIR-POWERED 711-A"

FASTER—because it's easier to handle! Saves lubrication time outdoors or indoors—anywhere in the plant. Pivot-swing dolly holds container upright at any pulling angle.

FASTER—because exclusive, newly designed pump packs more than enough power for every job. Delivers 14½ oz. of gun grease per minute at 70°F. Holds 25-, 35-, or 50-lb. pail—or 70 lbs. of grease. Dynamic primer assures positive priming.

Pivot-Swing Dolly For Easy Moving...

Electric-Powered "Porta-Kart"
Only 18" wide. Easily moves through narrow aisles. Capacity, 12 pounds. Delivers 13 oz. of pressure gun grease per minute. Automatic switch shuts off motor when 5,000 lbs. of pressure is built up. *Model 7182-B.*

Step up to modern, time-saving lubrication methods! Check Alemite's complete line of air-powered and electric-powered lubricators.

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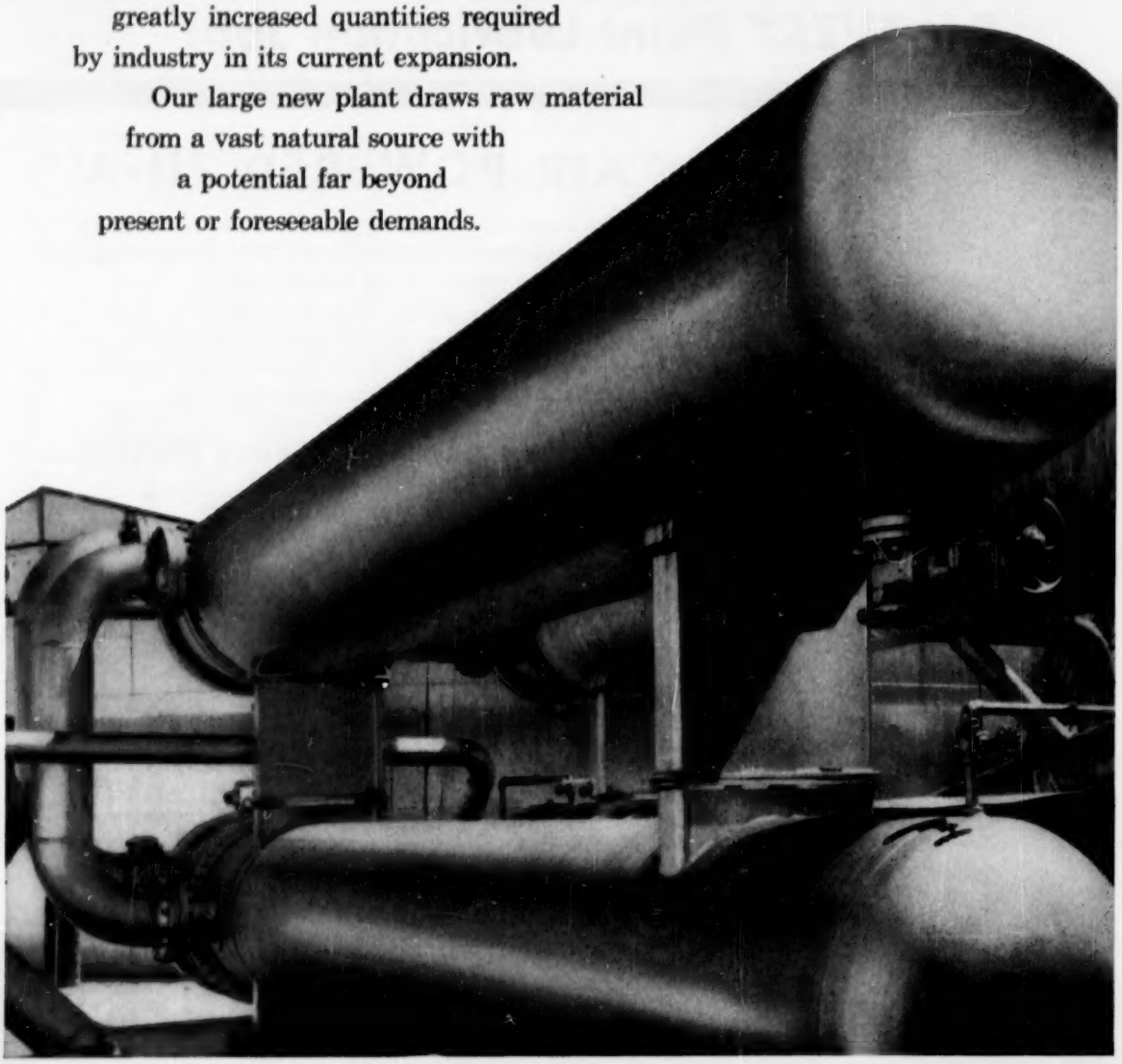
ANHYDROUS SODIUM SULFATE is a primary West End product and we have the production capacity to meet your needs

At West End, sodium sulfate is a prime product . . . not a by-product . . . and is being produced in the greatly increased quantities required by industry in its current expansion.

Our large new plant draws raw material from a vast natural source with a potential far beyond present or foreseeable demands.



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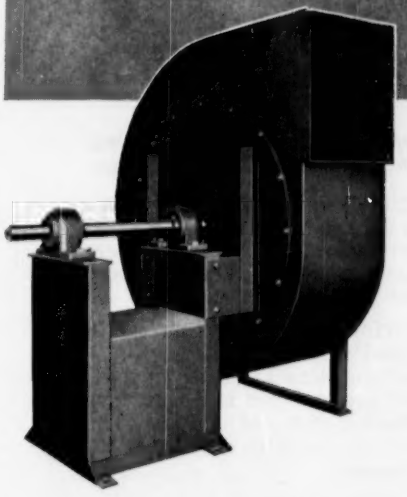
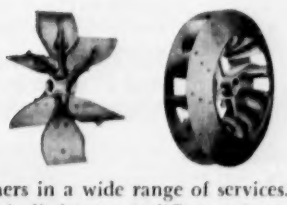
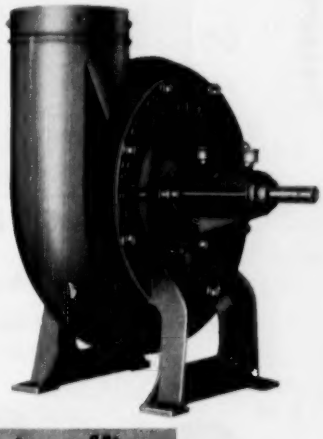
Clarage Industrial Air and Material Handling Fans



TYPE XL FANS. Distinguished by advanced design, high efficiency. Universal discharge, 3 different interchangeable wheel types available, reversible for either clockwise or counter-clockwise rotation with rim or open type wheels. Rugged, tight, fabricated steel construction. Pressures to 18" SP. **IMMEDIATE SHIPMENT** on all standard Arrangement 1 and 9 fans. Arrangement 4 and 8 fans also promptly available.





TYPE CI FANS. Proved performers in a wide range of services. Cast iron construction. Universal discharge, 2 different interchangeable wheel types available, reversible for either clockwise or counter-clockwise rotation. 6 sizes, pressures to 24" SP. **IMMEDIATE SHIPMENT** on all standard Arrangement 1 and 2 fans. Arrangement 4 and 8 fans also promptly available.

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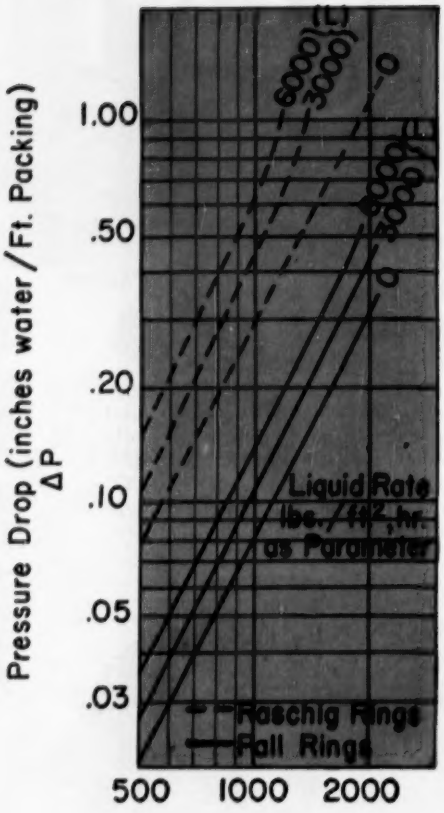
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

Cut Tower Volume 20% to 40%

with

METAL PALL RINGS



PRESSURE DROP vs. GAS RATE

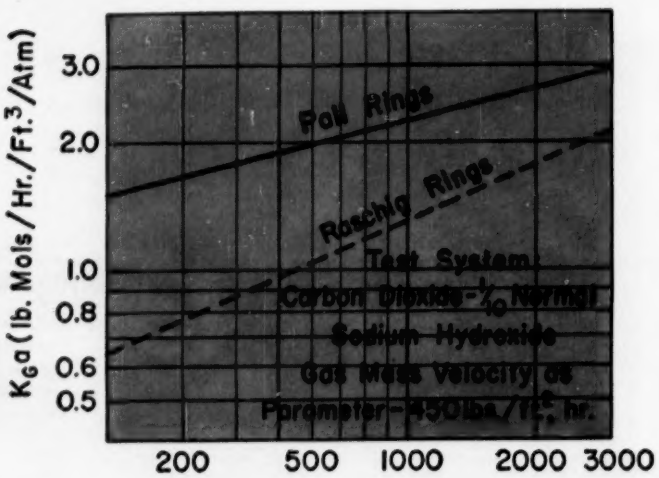
Where conditions suggest the use of metal packing rings in absorption operations, here's an important point to remember:

Tower volume can be reduced substantially by using metal Pall Rings in place of metal Raschig Rings.

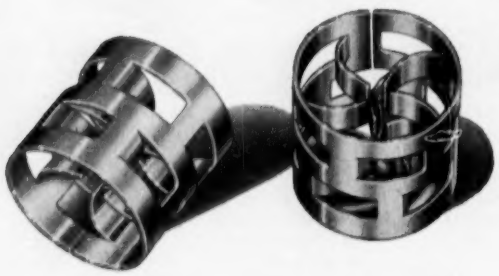
Take a careful look at the graphs. They show capacity data and pressure drop data taken from tests run not in an eight or twelve inch tower but in our new 30" diameter experimental tower. The tests were made using 1½" rings, packed to a depth of 8 feet.

This improvement in performance results purely from the characteristics of the Pall Ring. The Pall Ring differs from the conventional Raschig Ring in that sections of the ring wall are stamped and bent inward permitting better circulation of liquid and gas. Thus, more surface area is wetted resulting in greater active contact area between phases.

Metallic Pall Rings are made at present in 1", 1½" and 2" sizes in carbon steel, stainless steel, aluminum and copper.



MASS TRANSFER COEFFICIENT vs. LIQUID RATE



For full information —

on Pall Rings and on other tower packings, write for a copy of Bulletin TP-54.

U. S. STONEWARE

AKRON 9, OHIO

101-F

Chemical Engineering

Developments

DECEMBER 1957

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They've developed to the point where they account for 25% of chemical production. This month: methane derivatives.

A P-K Resin Pilot Plant may be the key to your company's future

Dr. Charles P. West, president, Resin Research Laboratories, explains features of P-K Packaged Pilot Plant used for resin and polymer product development

The longest distance traveled by a new product is from test tube to production resin reactor. But it can be shortened materially by proving out laboratory results in pilot plant operation before production is started.

Your investment in pilot facilities can be a modest one—if it's a P-K Resin Pilot Plant. These versatile units save original design cost, cut engineering time.

An example of the flexibility afforded by P-K Resin Pilot Plants is found at Resin Research Laboratories, Inc. and its affiliate, Polymer Engineering & Development Corp., of Newark, N. Y. These companies encounter a wide range of product research and development problems. And one of their most effective tools is the 15-gallon P-K unit shown above.

Standard P-K Resin Pilot Plants are made in 50 to 60 gallon capacities, and larger sizes can be made on request. These units can speed *your* product development work in many ways. For example, the smaller plants are ideal for testing and sampling.

The larger sizes can be used for both testing and small production runs. In addition, a P-K pilot unit can help you determine scale-up factors from lab to plant . . . find engineering design data for new processes . . . determine costs . . . define changes in existing processes to reduce costs . . . improve quality control procedures.

Says Dr. Charles P. West, president of Resin Research Laboratories: "Product research is an investment in survival, especially for small and medium-size companies. In any case, correct translation of laboratory results in a pilot plant can reveal substantial production economies that may be the measure of future profits."

If there's a new product in your future, get the full story of P-K Resin Pilot Plants. Write The Patterson-Kelley Co., Inc., 1512 Hanson St., East Stroudsburg, Pa. 14P

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DEVELOPMENTS . . .

DECEMBER 1957

Chementator

C. H. CHILTON

√ **A revolutionary new approach to thermal fixation of atmospheric nitrogen looks good in first test. It has big potential as low-cost route to fertilizer nitrogen.**

√ **Quebec Lithium Corp. may invade U. S. market with a lithium chemicals plant at Rouses Point, N. Y., just below Canadian border. U. S. plant would import duty-free concentrates from Quebec mine, would avoid heavy tariff on finished chemicals.**

√ **A Midwest firm has developed an entirely new concept in mothproofing, will start market development early next year. New treatment for fabrics is claimed to be stable, odorless, nontoxic**

√ **Government has finally accepted Dow's bid to buy magnesium facilities at Freeport, Tex. One-third of $20.7-million price will be paid now, balance within six years.**

Acetylene chemicals via low pressure

New frontiers in industrial chemicals from acetylene may open up as the result of pioneer research carried out by Lakeside Laboratories, Milwaukee producer of ethical drugs.

The new acetylene chemicals are described by Chief Chemist John Biel as unsymmetrically substituted diamines. They have never been made commercially—nor even offered in research quantities—primarily because the classical method of making them requires pressures of several thousand psi. Biel has now found a way to carry out the key reaction at atmospheric pressure and moderate temperature (110 C.).

Although Lakeside is evaluating various derivatives for possible pharmaceutical value, the firm expects the process—subject of a pending patent application—to find applications in many other fields.

First step in process is reaction of an amine (e.g., dimethyl amine) with propargyl bromide; the latter compound contains the triple-bond acetylenic linkage. Product of this step is the corresponding propargyl amine.

In the next step—now simple because of Biel's research—this material reacts with sodamide ($NaNH_2$) in toluene to form its sodium derivative. The latter is then reacted with a halogen-substituted amine to split out the sodium halide and form a diaminoalkyne, gateway chemical to a host of corresponding diamino derivatives—alkenes, alkanes, ketones, alcohols, esters, etc.

From these derivatives, Biel predicts, will come many new solvents, plasticizers, detergents, insecticides and polymers, as well as pharmaceuticals.

Ozone lands new process assignments

Ozone, the overdue oxidant, may be "arriving" right about now. Armour and Co. is busy with a pilot plant which oxidizes, with ozone, 1,000 lb./day of oleic acid to azelaic and

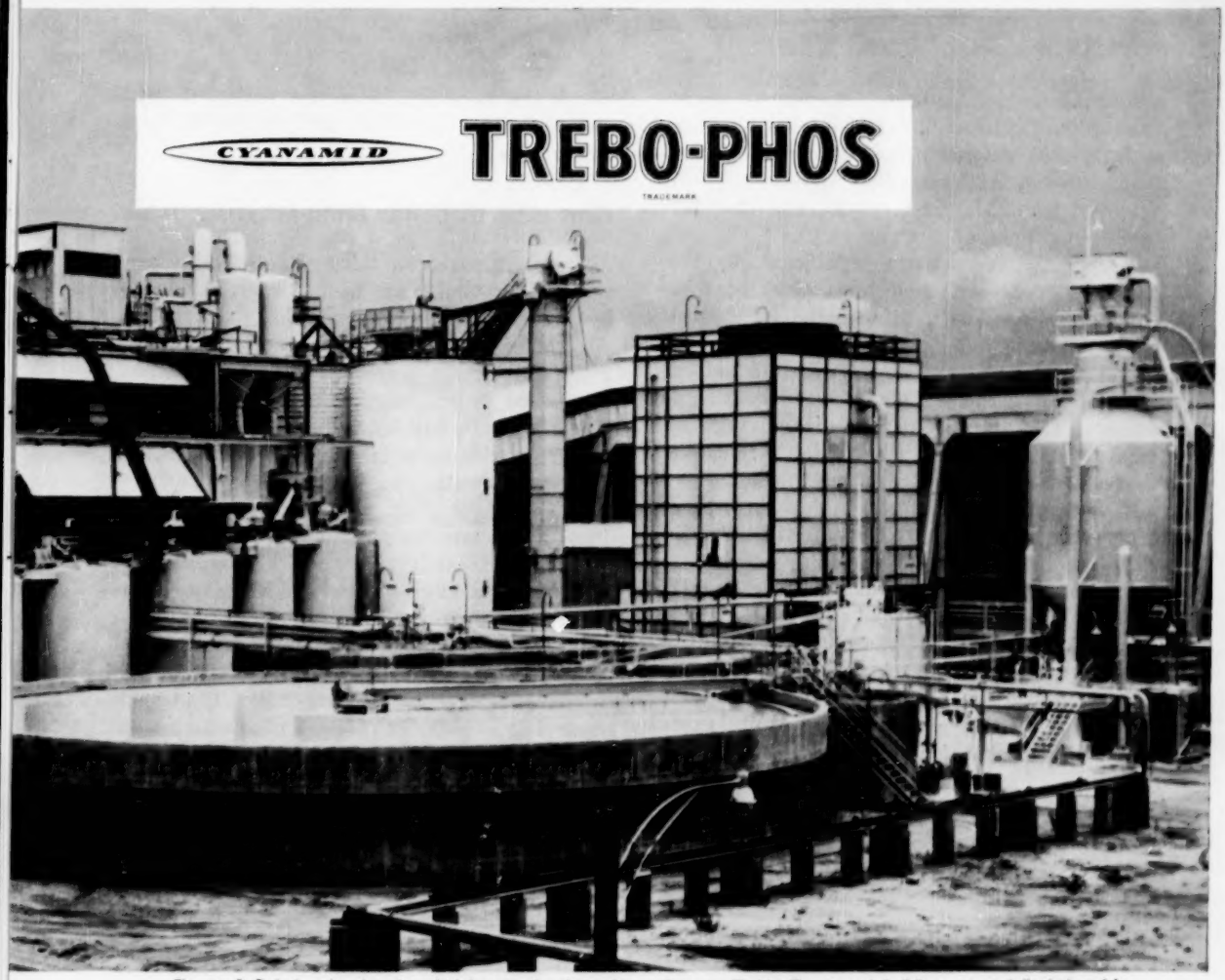
(Continued on page 142)

Dorr-Oliver
Designs
and Engineers

NEW 200,000 TON PER YEAR TRIPLE SUPER-PHOSPHATE PLANT

for American
Cyanamid Company
. . . at Brewster,
Florida

The new Brewster, Florida plant of the American Cyanamid Company, one of the nation's largest chemical corporations, reached its design capacity of 200,000 tons per year of triple superphosphate in less than 3 months after initial start-up. Operating with the largest single stream phosphoric acid reaction system, made possible by a new type of vacuum cooling device, this plant produces a non-granular fertilizer which is ideal for subsequent ammoniation and compounding. The daily production of 600 tons consumes 220 TPD of high strength P_2O_5, and 600 TPD of H_2SO_4. Dorr-Oliver's 40 years of experience in the field of phosphoric acid and concentrated fertilizer production was fully



The new D-O designed and equipped triple superphosphate plant at Brewster, Florida. The open air building was specially designed for light, ventilation and economy. Note the water recovery and neutralization section in the foreground, the outdoor reaction system, and the two Doyle Scrubbers on top of the building.

utilized in the design of this plant.

Already established as one of the cleanest fertilizer plants ever designed, the Brewster mill far exceeds all requirements of the Florida Pollution Authority. Fumes and gases are scrubbed in series through two Doyle Scrubbers which each handle 25,000 CFM. Acid wastes are neutralized and clarified prior to discharge. An absolute minimum of water is consumed as 3,200 gpm is reclaimed in a 90′ dia. Dorr Clarifier. Make-up water in the water reclamation plant totals 800 gpm or only 20% of the total process water.

Another D-O development is the Dorr-Oliver Traveling Pan Filter installation, where three 18 square meter units with a filtration area of 195 square feet are installed. Two of these units handle 1,100 tons of gypsum per day.

If you are considering entering the fast growing fertilizer field — or if you plan to expand present plant facilities — it will pay you to check with Dorr-Oliver. Write for Bulletin No. 8000, or better still, let us send an engineer to discuss your problem from the standpoint of economics and process. No obligation, of course.

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pelargonic acids. Another company—one of the top ten in chemicals—is also pilot-planting a fatty-acid oxidation process using ozone. And Boeing Airplane has under way at Wichita, Kan., the first commercial unit for ozone treatment of cyanide wastes.

Perhaps even more significant to the chemical processor, though, is news that he can now buy ozone by the pound. Welsbach Corp., Philadelphia, leading manufacturer of ozone-generating equipment, will now set up units at the customer's plant site without capital cost to the customer. By removing the capital investment deterrent, Welsbach hopes to really break open the ozone market.

Armour is producing a high-purity, polymer-grade azelaic acid to compete with sebacic acid in polyamides and in specialty jet-aircraft lubricants. The only other azelaeic maker, Emery Industries, Cincinnati, has been using ozonolysis for several years to carve out a 5-million-lb./yr. market for a product suitable for plasticizers and lubricants.

At the Boeing plant, ozone's capital costs are no greater than those for conventional chlorination treatment of cyanide wastes. Operation, however, is less costly, and is far simpler because there's no overdosage problem, no toxic oxidation products to build up in treated effluent.

New wells will probe oil sands

In efforts to effect a major breakthrough in tapping Alberta's oil-rich Athabasca tar sands, Richfield Oil Corp. is launching a large-scale experimental program by drilling 21 wells this winter.

Wells will serve a threefold purpose: They will help determine thickness and value of underground deposits in area under lease; they'll permit tests on feasibility of oil recovery from the sands by *in situ* combustion; and they will also fulfill well-drilling obligations required to retain lease.

In addition, Richfield has surface deposits and is now digging core holes to measure the thickness of these. A mining project, in addition to the drilling venture, may prove worthwhile.

Athabasca sands hold an estimated 300 billion barrels of oil. Other firms actively interested in Athabasca oil wealth include Shell, Union, Sun and several Canadian oil companies, such as Royalite Oil and Calvan Consolidated. Royalite plans to exploit a recovery process in which the sand will be mixed with a diluent and spun in a centrifuge to free the oil from the sand.

New class of resins from ethylene oxide

An unusual new class of potentially low-cost, water-soluble resins has been developed by Union Carbide Chemicals Co.

Called Polyox, they are exceptionally high-molecular-weight polymers of ethylene oxide. Compared to company's Carbowax polyethylene glycols formed by linking as many as 500 ethylene oxide units into linear structures, the new resins contain up to 100,000 such units.

They have great promise as films or coatings which are tough and stiff, yet readily formed and easily removed. The resins can be used as packaging materials when the product inside is to be dissolved or dispersed in water, e.g., paints, detergents, agricultural chemicals, foods, pharmaceuticals. These films are expected to be less expensive than such materials as polyvinyl alcohol film, which have already been used in this type of application.

Efficient warp sizes for textiles, they have no biological oxygen demand—important in this increasingly pollution-conscious era. Cost would be competitive on a performance basis with starch.

Carbide hopes that Polyox will develop large-scale markets for ethylene oxide. (Predictions for total production of ethylene oxide in 1959 are at the 1.5-billion-lb. mark.) Carbide is now producing the resins in South Charleston, W. Va., in semicommercial quantities. Substantial commercial-scale production is scheduled for early next year, and plans are now being formulated for a large-scale unit to be completed in 1960.

How to upgrade coke oven ammonia?

What can coke-oven operators do with their byproduct 30% ammonia liquor in the face of today's high-analysis-fertilizer trend which is depressing the market for low-analysis ammonium sulfate?

While one answer seems to be the switch to ammonium phosphate (e.g., Colorado Fuel & Iron, Ford Motor), Paul Caldwell, Chicago chemist and inventor, has come up with another.

Caldwell proposes to strip the liquor with

(Continued on page 144)

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warm air, oxidize the stripper overhead to nitrogen oxides and thereby produce nitric acid. He would use this acid, plus phosphate rock, potash and additional ammonia (no sulfuric or phosphoric acid) to make a high-analysis (13-13-13) nitrophosphate fertilizer that's free of fluorine. As an added economic fillip, fluorine would be readily recovered as potassium silicofluoride at a low-enough cost, says Caldwell, to compete with sodium silicofluoride in the aluminum and vitreous enamel markets.

In Caldwell's fertilizer process (U. S. 2,778,712), phosphate rock is first acidulated with straight nitric acid. The resulting product is clarified via filtration—an important step—then treated with KCl to precipitate K_2SiF_6, which is filtered out. Next step is removal of part of calcium present; details won't be available on this until another patent issues.

Finally, the nitrophosphate liquor is ammoniated, fortified with more potash and crystallized as a nonhygroscopic product.

Caldwell estimates that such a fertilizer plant would have to turn out 100,000 tons/yr. of mixed goods to be economical. However, there are a number of areas in the U. S. where byproduct ammonia liquor is available in sufficient quantity—Chicago, for one.

And as evidence that such ammonia is a drug on the market, Caldwell reports that one Chicago steel mill, now doubling its coking capacity, plans to dispose of its increased NH_3 to the atmosphere, dumping it on the slag pile in order to thermally dissociate it into hydrogen and nitrogen.

Magnetism goes four ways in new steel

A new kind of magnetic steel, which allows magnetism to turn corners, promises to improve performance and simplify construction of electrical apparatus. Announced by Westinghouse Research Laboratories, Pittsburgh, the development is based on metallurgical processes originated by Vacuumschmelze of Hanua, Germany.

Controlled crystal orientation allows the new steel to be magnetized easily in four directions. Trade-named "Cubex," it is technically known as "doubly oriented" or "cube-oriented" silicon iron. It is expected to be used in the magnetic cores of electrical devices such as transformers and motors.

Conventional magnetic steel is "singly oriented." To provide the best magnetic path all around the rectangular core of a large transformer, the core is built up of straight strips of metal laid at right angles in a rectangular shape.

In the case of the new material, L-, E-, U-shaped or even rectangular punchings could be stamped from a sheet of steel in one operation. This would simplify construction of the core, besides giving an improved magnetic path.

Cubex steel has about the same chemical composition as the standard magnetic variety —about 3% Si. Real difference between the two comes from the way the steel is handled during its processing from rough sheet into final product.

Cubex steel is still in the laboratory stage. Specialized uses requiring only thin sheet will no doubt be first commercial applications, possibly within the next few months.

New method slashes uranium leach time

Capital outlay may be much less for future uranium alkaline-leaching circuits. Pilot trials just completed by National Lead Co. at Grand Junction, Colo., which cut leaching time from two days to 80 min., point to much smaller equipment and in-process inventories.

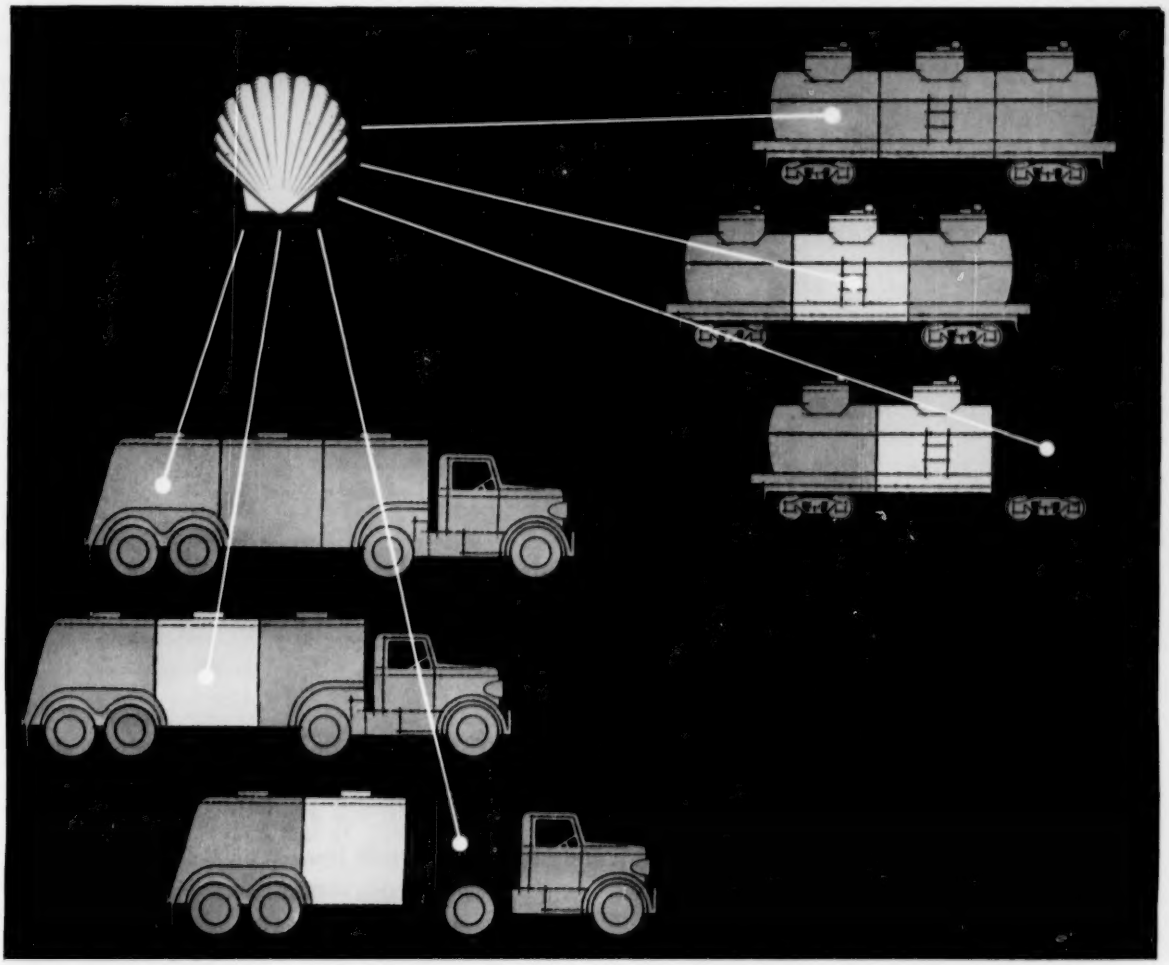
New technique involves oxidation of low-valency uranium with air in the presence of copper sulfate and ammonia during leaching. Current practice is to use potassium permanganate as oxidizing agent.

When leached with sodium carbonate, low-valency uranium forms uranous carbonate complex ion which breaks down into insoluble uranous hydroxide at high leach temperatures. However, once oxidized, uranium forms a uranyl tricarbonate complex ion which is stable at high temperatures and is completely soluble in carbonate leaching solutions.

New process was investigated first by A. D. Little, Inc., San Francisco. National Lead has proved it out at atmospheric pressure and also at 50 psi. in autoclaves. Successful future practice will likely use autoclaves to gain minimum capital outlay.

Increasing need for carbonate leaching—as opposed to acid leaching—stems from rise in output of acid-hungry high-lime ores. Three large new mills now being built will use carbonate leaching.

For more on DEVELOPMENTS.....146



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If you're looking for a proved way to cut your solvent costs, one of the best methods is through multi-product deliveries. Here's how it works:

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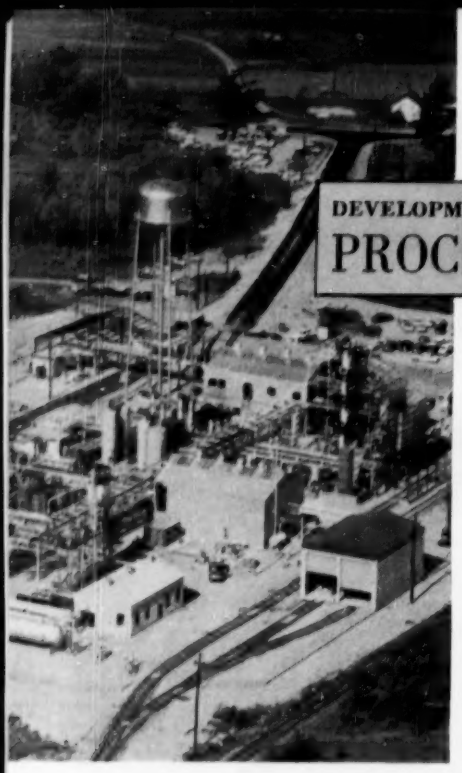

DEVELOPMENTS . . .

PROCESSES & TECHNOLOGY

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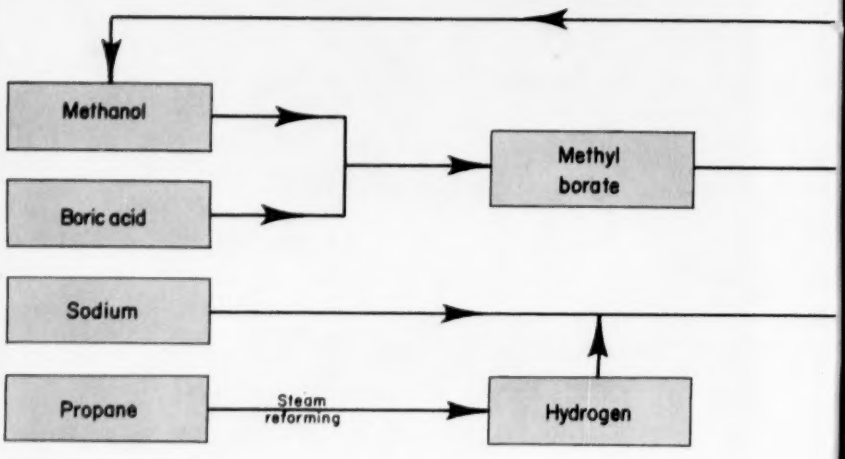


First Tonnage Sodium Borohydride:

Volume production for military use will lower costs, help open up greater commercial application of this effective reducing agent.

SODIUM borohydride, key intermediate for making boron-based high-energy fuels, is now pouring forth in tonnage quantities from Metal Hydrides Inc.'s new $5.4-million plant in Danvers, Mass., put on stream in October. Product is going to Olin Mathieson's new plant at Model City, N. Y., for conversion into the final fuel form.

While many aspects of the project are under either Navy or company security wraps, enough is known to provide chemical engineers with significant engineering, process and business information, such as:

• Process is described as essentially continuous, including a unit for continuous production of methyl borate from boric acid and methanol.

• Despite New England's severe winter climate, construction is largely of the outdoor type, simplifying ventilation problems and reducing plant cost.

• New plant and process can make sodium borohydride, a white crystalline solid, at well under $5/lb., opening up greatly increased commercial potential for this useful reducing agent.

▶ **High-Energy Push**—MHI has been making sodium borohydride on a commercial basis since 1951, reaching a production volume last year of some 20,000 lb.

Major outlet for the commercial product is the pharmaceutical industry, which uses it particularly for the manufacture of cortical hormones, antibiotics and vitamins. It's a specific reducing agent for the carbonyl group of aldehydes and ketones.

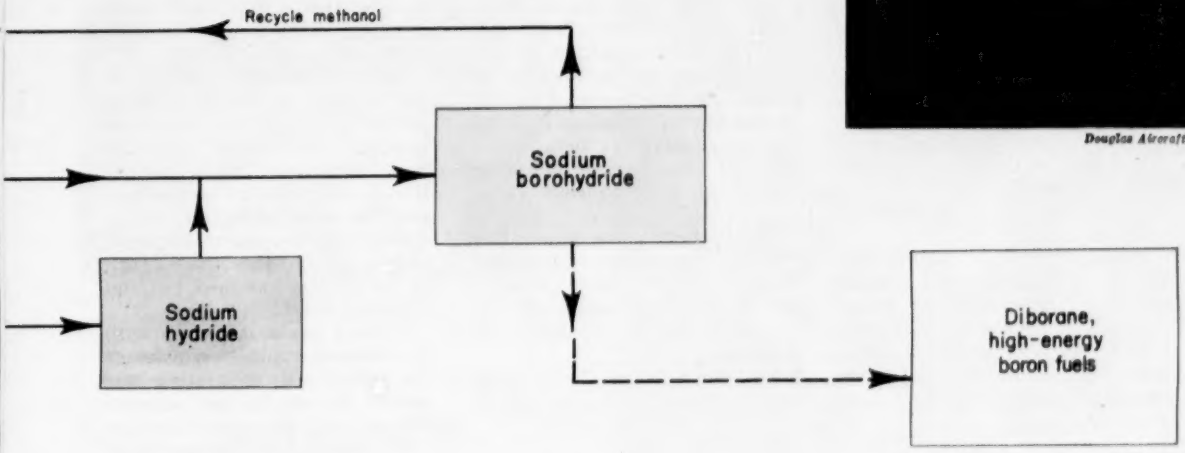
Today's big push for $NaBH_4$, of course, is based on its essential role in production of high-energy fuels. According to MHI, diborane (B_2H_6), gateway chemical to such potential fuels as pentaborane and decaborane, can be made by reaction of sodium borohydride with either BF_3 or BCl_3 in a glycol ether solution.

▶ **Navy Dollars** — MHI's new Danvers plant—which, in comparison, dwarfs the company's $2-million worth of older installations at nearby Beverly—was financed largely by the Navy. In addition to its process know-how, MHI provides site, improvements thereon, rail sidings and all buildings, amounting to an investment of about $1 million. The Navy paid for procurement and installation of $4.4-million worth of equipment.

MHI's production contract with the Navy calls for delivery of $9.2-million worth of product over the next 18 months, but neither total quantity nor unit price have been revealed. Assuming a unit price of $5/lb., plant output need be only 2 tons/day to supply the contract. However, a company spokesman confirmed that rated capacity of "several" tons per day implied substantially more than "two."

▶ **MHI Process**—Basic process for making sodium borohydride

Douglas Aircraft



Vital Link to High-Energy Fuels

is the reaction of sodium hydride with methyl borate. Methanol freed by the reaction is recovered and reused to make more methyl borate by reacting it with boric acid.

MHI makes sodium hydride from sodium metal and hydrogen. Whereas the Beverly plant got its hydrogen via electrolysis, the new Danvers plant incorporates a Girdler package unit for reforming propane (or "farm gas," as many New Englanders call it). Net raw materials consumed at Danvers, therefore, are propane, sodium and boric acid, plus makeup methanol.

▶ **Divide and Conquer** — Major process improvement incorporated in the new plant is use of an oil dispersion of sodium hydride in the borohydride reaction. The dispersion consists of a suspension of NaH crystals, 5-25 microns in particle size, in an inert mineral oil. Advantages of the dispersion system:

- It can be pumped and metered as a fluid.
- It is more reactive than dry NaH, yet is much safer to handle.
- Oil provides a heat sink, greatly simplifying the heat-transfer problem created by the exothermic borohydride reaction.

Although proud of its own borohydride research, development and engineering team, MHI acknowledges assistance received from Arthur D. Little, Inc., in developing the continuous methyl borate process. The company gives Badger Mfg. Co., designer and construction engineer of the Danvers plant, major credit for pushing the project through to completion on a fast schedule, assisted by ideal construction weather.

Northeastern University also comes in for a share of praise for its part in foreman and operator training.

▶ **Fast-Moving Field** — Metal Hydrides' new plant, although significant, is but a small part of the rapidly growing high-energy-fuels picture. Among others active in this field:

- Olin Mathieson, whose $4.5-million Navy plant at Model City, N. Y., will use MHI's sodium borohydride, is also building a $36-million boron fuels plant there for the Air Force.
- Callery Chemical, jointly owned by Mine Safety Appliances and Gulf Oil, is building a boron fuels plant at Muskogee, Okla., under a $38-million Navy contract.
- American Potash, National Distillers and Food Machinery have just teamed up to form AFN, Inc., with an Air Force contract already in the bag to cover process development and semipilot work on boron-based fuels at Henderson, Nev. American Potash is already pilot-planting decaborane (*Chem. Eng.*, Sept. 1957, p. 172), in addition to operating a Navy plant at Henderson for production of ammonium perchlorate rocket fuel (*Chem. Eng.*, Dec. 1955, pp. 334-337). National Distillers is basic in sodium, while FMC makes hydrazine and peroxides.
- Hooker Electrochemical and Foote Mineral plan a joint move into the HEF field with lithium or ammonium perchlorate, which would be made in a unit adjacent to Hooker's sodium perchlorate plant in Niagara Falls.

(*Continued*)

Although defense requirements for high-energy fuels can change quickly—because of changing domestic or international conditions or by virtue of obsolescence—chemical engineers like Metal Hydrides' Plant Engineer Frank Wilson (MIT '43) find it a fascinating business.

Solvent Extraction Gets Rare Metals

Solvent extraction process used successfully for uranium is now being aimed at winning of other metals.

Researchers C. J. Lewis and E. H. Crabtree at Colorado School of Mines Research Foundation are trying to obtain yttrium, thorium, vanadium, molybdenum, titanium and other metals by modifying their uranium extraction method. Results to date have elicited cautious optimism for method's future applications.

Here's what's involved: Metal-pregnant aqueous solution is contacted with a water-immiscible phase of kerosene and a phosphate ester solvent. Metal ion migrates from aqueous to organic phase, and equivalent ion enters aqueous phase. The two phases are separated on basis of their immiscibility; metal ion is removed from organic phase by contacting with aqueous stripping agent.

Major finding to date: For optimum metal-ion extraction with organophosphate solvent, pH of aqueous phase should increase as basicity of metal increases.

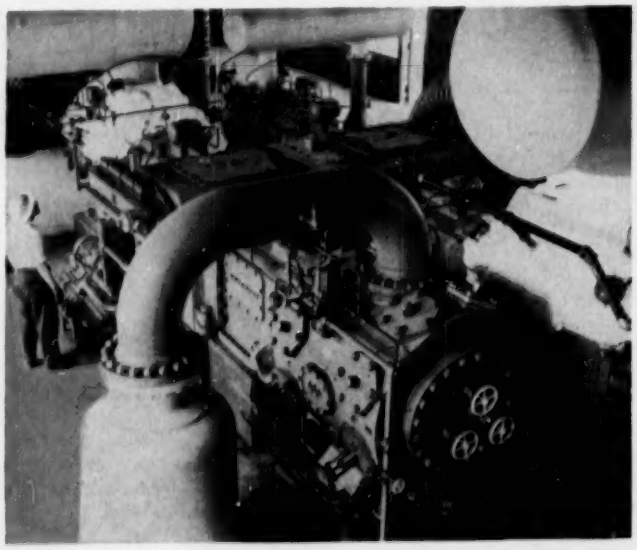
▶ **Another Version**—R. C. Vickery of Horizons Inc. in Cleveland, Ohio, has come up with his own adaptation of the process for extracting rare earths.

Vickery's process substitutes petroleum ether as carrier for solvent. (He uses 2-diethyl hexyl phosphoric acid; Lewis and Crabtree use this and an assortment of other esters in their extractions.)

Using ammonium citrate as the aqueous stripper, Vickery claims lab separations have averaged 97% recovery of individual rare earths at 99.5% purity. Mixed chlorides of samarium, gadolinium and europium, for instance, can be separated much more readily by this process than by the standard method, sodium-amalgam reduction.

Vickery has a lab setup with liquid-liquid contacting columns for continuously separating rare earths, figures he can separate 900 gm./day of mixed chlorides.

It's too early to discuss plant-scale operation of process. But if it works as expected, commercial production would not require a large unit. And Vickery feels process will be competitive.



Big Petrochemical Plant on Stream in Canada

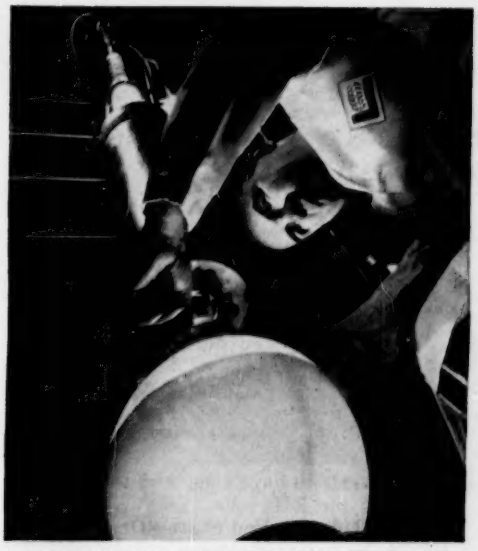
Refrigerator-compressor units, shown above, cool hydrocarbon gases to low temperatures during purification at the Montreal East petrochemicals plant of Union Carbide Canada's Carbide Chemicals Div. Now in operation, the plant is slated for a boost in polyethylene capacity to 30 million lb./yr. early next year. Plant also makes ethylene oxide and derivatives. In designing ethylene oxide unit, engineers used an IBM 650 computer to figure optimum operating conditions.

Extractive Metallurgy To Be Feted at Dinner

Seventy-seven organizations in government and industry who spearheaded the rise of "chemical" metallurgy will be honored at the Chemical Engineering Achievement Award Dinner December 3 in the Waldorf-Astoria Grand Ballroom in New York.

Walter G. Whitman, chairman of the award committee, will present the 1957 award, which recognizes the pioneering application of chemical engineering principles and processes in metallurgy of the atomic-age metals (*Chem. Eng.*, Oct. 1957, p. 148). Accepting the award on behalf of government and industry will be Jesse C. Johnson, director of Raw Materials Div., Atomic Energy Commission.

Keynoting this gathering to honor the metal pioneers will be an address by Zay Jefferies, former vice president and general manager of General Electric Co.'s chemical department. Title of the address: "Chemical Engineering and Extractive Metallurgy—A Fruitful Partnership."



BENCH-SCALE DISTILLATION EQUIPMENT. The Center has various types and sizes of apparatus to distill any size sample from one cc to a tank-car load.

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At a new 150,000 square-foot Center near the Newark Airport, the Lummus Company is expanding a long-established engineering development program into a major service to the process industries. The intensive pilot plant investigations carried out here will, in the years to come, spell the difference between rash gamble and sound plant investment for many manufacturers in the chemical, petroleum, pulp and paper and allied fields.

For a complete description of The Center and how it can help you bridge the gap between laboratory research and successful production, write for the 16-page brochure "Lummus Engineering Development Center." Address The Lummus Company, 385 Madison Avenue, New York 17, New York.

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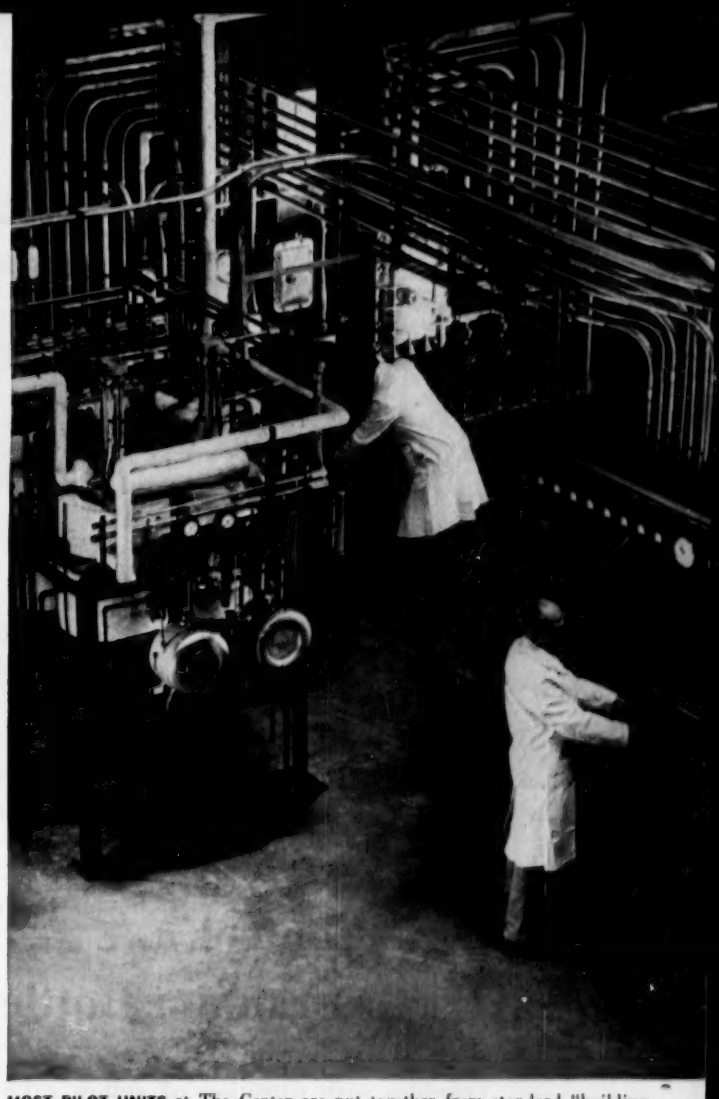
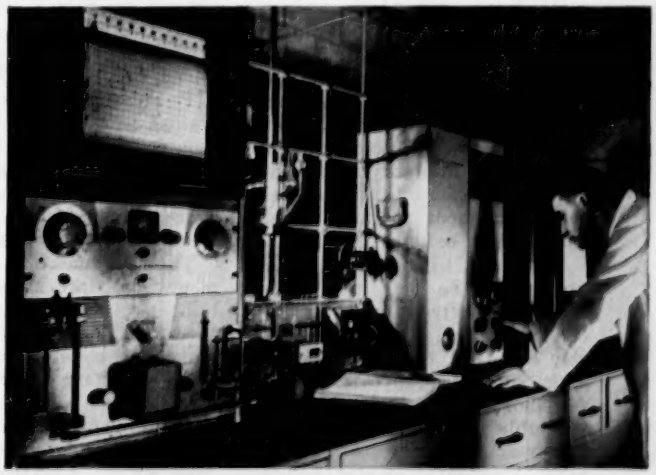
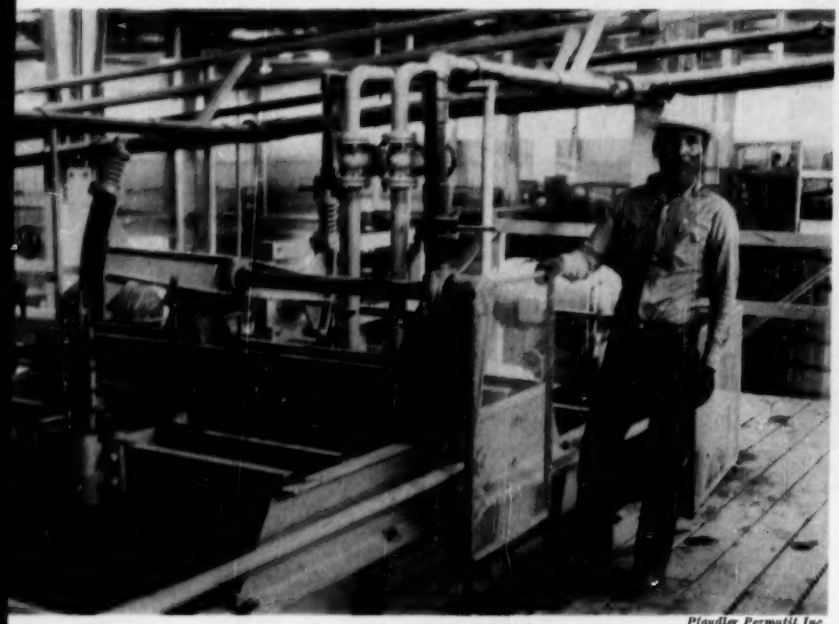


MOST PILOT UNITS at The Center are put together from standard "building blocks." Skid-mounted charging units such as the one at left hold tanks, heaters and pumps for transfer and metering. Process equipment, here shown in background center, can be widely varied. At right is electrical control cabinet. All switches, relays and controls not housed in explosion-proof boxes are enclosed in cabinets like this one, pressurized with outside air to exclude process vapors.

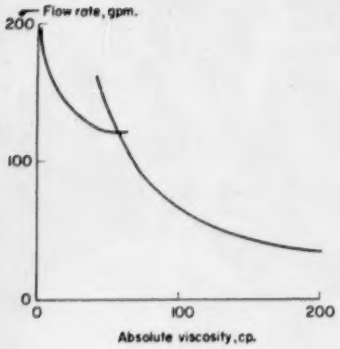


ANALYSIS OF MATERIALS processed and produced in pilot operations at The Center is an important part of the work carried out by Lummus engineers. Here a laboratory technician determines the composition of a multiple-component gas, using a gas chromatography technique.



Pfaudler Permutit Inc.

FLOW rate through RIP ion exchange unit depends on pulp viscosity.



Close pH Control . . . . . Eases Uranium Bottleneck

Troubles with filtration of yellow cake and low flow through RIP circuit were throttling uranium plant output. Here's how operators solved these problems.

Heads-up, behind-the-scenes operating skill has opened major bottlenecks in Rare Metals Corp.'s resin-in-pulp uranium extraction plant at Tuba City, Ariz. Beset by dwindling flow through the RIP circuit and yellow-cake filters, plant engineers sharpened up their process control methods to boost plant output back to normal.

For Tuba City, the acid-RIP process is the only way Rare Metals can extract uranium successfully from Cameron high-clay ore. Yet, for many months after startup, even this process fell short of expected goals.

▶ **Double Trouble** — Initially, yellow-cake precipitate (ammonium diuranate) varied widely in filterability. At times, filters took up to 8 hr. to fill with slimy, difficult-to-filter yellow-cake solids.

Long before this riddle was solved, trouble developed in the RIP circuit. The gravity-flow system was not delivering the required flow rate of leached ore pulp to the ion exchange banks. Much of the time the pulp appeared viscous and actually cemented the resin beads.

Through months of experimentation, Rare Metals' production personnel wrestled with these troubles to pin down causes and apply countermeasures. To a large extent they have succeeded. Close control of pH to an optimum range paves the way to good yellow-cake precipitate and satisfactory filtration. And a change in the method of pH adjustment prior to ion exchange seems to have smoothed out flow to the RIP cells.

▶ **Off to a Bad Start**—Ore from the Cameron mining district contains appreciable amounts of bentonitic clay. Rare Metals attributes its major operational problems in the plant to the presence of this clay in the ore.

Originally, incoming ore was blended to control mill feed grade (uranium content) and lime content. Now, blending is used also to control milling characteristics (which are related directly to the amount of bentonitic clay in the ore).

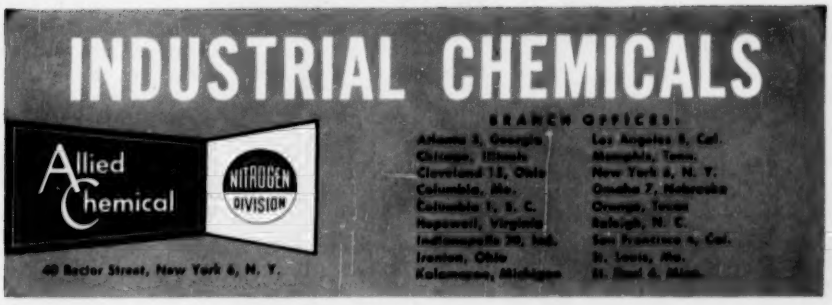
▶ **Leach in Mill**—Blended ore, hot water (150 F. or higher) and sulfuric acid mingle in the scoop box of a ceramic-lined pebble mill. Use of this mill permits grinding in acid media to achieve as much as 90% of total uranium leaching during 6-min. residence in mill (*Chem. Eng.*, Sept. 1957, p. 144).

Hard ores, comprising 5-10% of plant's feed, are ground in water in a rod mill. Acid is added later in the conventional leaching circuit.

Rake classifiers, in closed circuit with mills, recirculate underflow back to mills for further grinding. Overflow discharges to conventional wooden leach tanks where leaching of uranium is completed. Addition of MnO_2 oxidizes any reduced uranium to the hexavalent form.

Sand fraction of leach residue is removed by liquid cyclones and fed through a series of washing classifiers before discharging to tailings. Secondary and tertiary cyclones operate on overflow from classifiers and primary cyclones to produce feed for ion exchange.

▶ **pH Adjusted** — Cyclone dis-



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Hygroscopic, non-corrosive liquid with many uses.

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Low volatility, high boiling point liquid with many uses.

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Used in virtually every industry, easy to handle, reactive. Triethanolamine available in two grades—commercial and 98%.

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Available as 37% Inhibited, 37% Low-Methanol, 45% Low-Methanol, 50% Low-Methanol.

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Synthetic methyl alcohol of 99.85% purity.

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N_2O_4 as oxidant for liquid rocket propellants has higher energy than hydrogen peroxide, red or white fuming nitric acids and mixed acid.

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A white crystalline salt of high purity containing a minimum of 99.5% $NaNO_3$. Supplied in three grades *at no extra cost*—coarse, medium and fine crystal sizes to meet exacting process requirements.

UREA:

A white, crystalline solid, Crystal Urea (Carbamide) is a high-purity product made to meet rigid specifications. It is used in an extremely wide range of products and processes.

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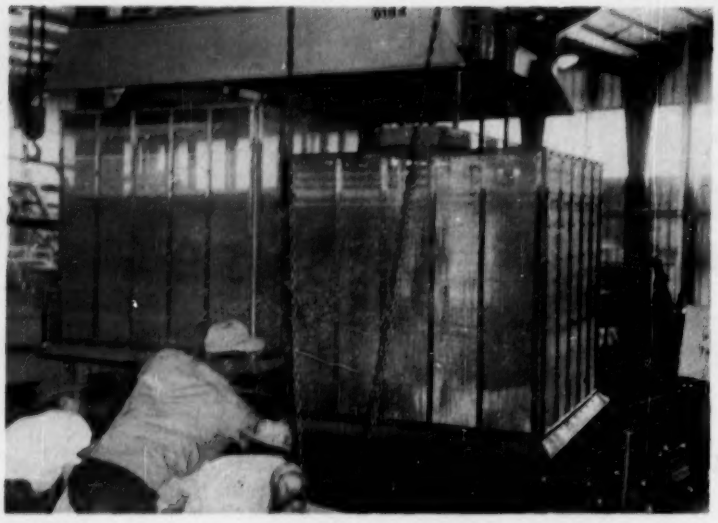
products are the result of more than 60 years of experience. They are backed by high standards of quality, enterprising research, technical assistance and prompt service. We welcome inquiries about any of these products or derivatives of them.



RESIN in these baskets contacts pregnant pulp in tea-bag fashion.

charge is held in one of three 30,000-gal. wooden tanks. Batch in tank is adjusted to pH 1.5 with lime, and the vanadium is reduced by addition of powdered iron.

Previously, pH was adjusted at this point by addition of ammonia. Even though corrected pH was adjusted to 1.5, pulp viscosity varied substantially. Apparently this was related directly to variations in the quantity of slimes and dilution water entering the RIP circuit. This in turn affected the ammonia requirement and the resultant viscosity.

Lime now seems to give the desired pH without contributing to unfavorable viscosity conditions.

Conditioned feed is pumped to a constant-head tank which feeds the exhaustion banks of the RIP circuit. Pulp flows through the banks by gravity and discharges to tailings.

Nine banks of resin baskets handle feed while five are undergoing elution.

Loaded resin is eluted with acidified nitrate solution. After polishing in a filter press, the pregnant eluant flows to 21,000-gal. wooden tanks for precipitation of ammonium diuranate yellow cake.

▶ **Flocculant Fails**—Originally, Tuba City precipitated yellow cake by adding anhydrous ammonia until pH reached 7. Carried out at ambient temperature, this method formed a slimy, slow-settling, poorly filtering precipitate.

Laboratory tests indicated that judicious application of a powerful flocculant would overcome this trouble. But, in practice, judicious application failed. Slimy precipitate still formed, necessitating reductions in tonnage to the mill while filters took up to 8 hr. to fill.

▶ **MgO Does the Trick**—Rare Metals operators eventually found that they could adjust eluant pH to 5.0-5.5 with ammonia, then precipitate a readily filterable ammonium diuranate with MgO. Only one 80-lb. bag of MgO is needed every 18-24 hr. to treat 18,000 gal. of pregnant liquor. Filtration proceeds so rapidly that filters fill in approximately 25 min., with an occasional batch requiring as little as 3 min.

If one bag of MgO fails to produce pH 7, more ammonia can be added without harming the filtering speed. However, if MgO is added initially to a batch which is outside the 5.0-5.5 pH range, the precipitate will be hard to filter.

After filter cake has been washed and blown, it is repulped and pumped to a steam-heated dryer. Dried product yellow cake falls directly into shipping containers.

Soviets Use Two Routes In Heavy Water Plants

According to the German publication, *Chemische Industrie*, Russia now has two big plants turning out heavy water.

The larger produces 60 tons/yr. of heavy water, using the dual-temperature hydrogen sulfide-exchange process to enrich water to 5% D_2O. This is followed by electrolytic enrichment to 99.8% heavy water.

Dual-temperature process is based on deuterium exchange between hydrogen sulfide and water. Equilibrium constants are such that high temperatures favor deuterium-rich sulfide, while low temperatures enrich the water. When natural water and hydrogen sulfide are run through a hot tower (at, say, 100 C.), deuterium in the water exchanges with hydrogen in the sulfide to give a sulfide richer in deuterium. Then this sulfide and water of normal deuterium content are run through a heat exchanger and a cold tower (at, say, 25 C.) to enrich the water. In the Soviet plant this cycle is repeated until the water is enriched to 5% D_2O content.

The smaller Russian plant, of an estimated 30-40-ton/yr. capacity, employs a different exchange pair, ammonia-hydrogen. This exchange pair, however, requires catalysis.

Stancal to Erect Hawaiian Refinery

With the acquisition of a 310-acre site 15 mi. from Honolulu, Standard Oil of California's three-year-old dream of an Hawaiian refinery is finally coming true.

Stancal will spend $40 million in building the 35,000-bbl./day refinery. Construction is slated to start early in 1958; when completed the unit will employ 225 people.

Plans call for a submarine pipeline running 2 mi. from shore out to a 60-ft. depth so that world's largest crude tankers can be unloaded at the refinery.

Installation will occupy one-fifth of the industrial zone in a region set aside for the eventual building of a "dream city."

When Specs Demand Job Matched Piping and Fittings One Call Will Do it All—B&W

The layout has been made. Erection schedules are in the planning stage. What you do now in contacting a source of supply for your alloy steel pipe fittings and flanges, can very well be one of your most important moves.

If you call on B&W, you can be assured of benefits that simplify scheduling problems. With one call to B&W—on one order—you can obtain matched pipe, fittings and flanges to meet your specific requirements. What's more—the delivery of the alloy steel pipe, the seamless welding fittings, and the forged steel flanges that make up the integrated system you desire—can be coordinated. This is just one more reason why B&W has earned the reputation and acceptance as "the natural source" for alloy pipe and fittings.

Call on Mr. Tubes at your nearby B&W Tubular Products Division District Sales Office—let him coordinate your alloy steel pipe, seamless welding fittings and forged steel flange problems. He can help you. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

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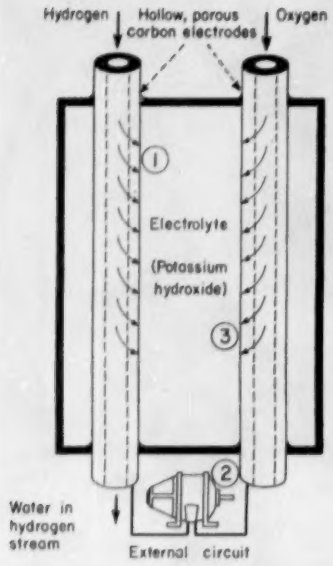
Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steel.



(1) Hydrogen diffuses through electrode, reacts with electrolyte

$$H_2 + 2\,OH^- \rightarrow 2H_2O + 2e$$

(2) Electrons liberated by reaction flow through external circuit, do work

(3) Oxygen diffuses through electrode, reacts with electrolyte and returning electrons

$$O_2 + H_2O + 2e \rightarrow HO_2^- + OH^-$$

Peroxide ion decomposes chemically

$$HO_2^- \rightarrow \tfrac{1}{2}O_2 + OH^-$$

Net reaction:

$$H_2 + \tfrac{1}{2}O_2 \rightarrow H_2O$$

FOR SILENT, PORTABLE POWER

First Practical Fuel Cell

Here's how they work, but don't look for low-cost electricity from these energy-thrifty devices until research engineers clear some mighty high hurdles.

How practical, really, is the fuel cell?

Talk of 100% fuel efficiencies, cheaper electricity and everything else associated with fuel cells has been greatly fomented in recent months.

The stimulus: National Carbon Co.'s announcement in September that it had developed the first practical fuel cell "capable of economically producing thousands of watts of power." Electricity comes directly from electrochemical reaction of hydrogen and oxygen at energy yields up to 80% of theoretical.

National Carbon's cells are now powering the Army's "silent sentry" portable radar set.

▶ **Talking It Over** — Following close on the heels of this announcement was a timely—and lively—round-table discussion of fuel cells at a meeting of the Electrochemical Society in October at Buffalo. Brought into focus at this well-attended session (estimated 200) was just what we can and cannot expect from fuel cells. Here's a boil-down of meeting's conclusions:

- Fuel cells have a tremendous potential for world's future energy needs.
- But today, fuel cells are far from cheap (1¢/kwh.) sources of electricity.
- Nonetheless there are many potential fuel cell applications, both military and commercial, short of central-station electricity.

Development of a low-cost fuel cell system would put the chemical engineer solidly in the power-generating business. And it would cause a minor revolution in power-company economics. So fuel cell developments are being closely watched.

▶ **Congratulate Carbon**—Secret of National Carbon's cell which triggered much of this excitement: Chemically treated, hollow, porous carbon electrodes which admit reactants to cell and conduct electricity out. Electrode treatment (or "black art") is a well-guarded secret.

Cell itself consists of a sealed jar containing several electrodes surrounded by an electrolyte—a potassium hydroxide solution. Hydrogen and oxygen are fed separately into the cell, react within the cell to produce water and electricity. Electricity is routed to an external circuit; water is disposed of by evaporation into the hydrogen stream.

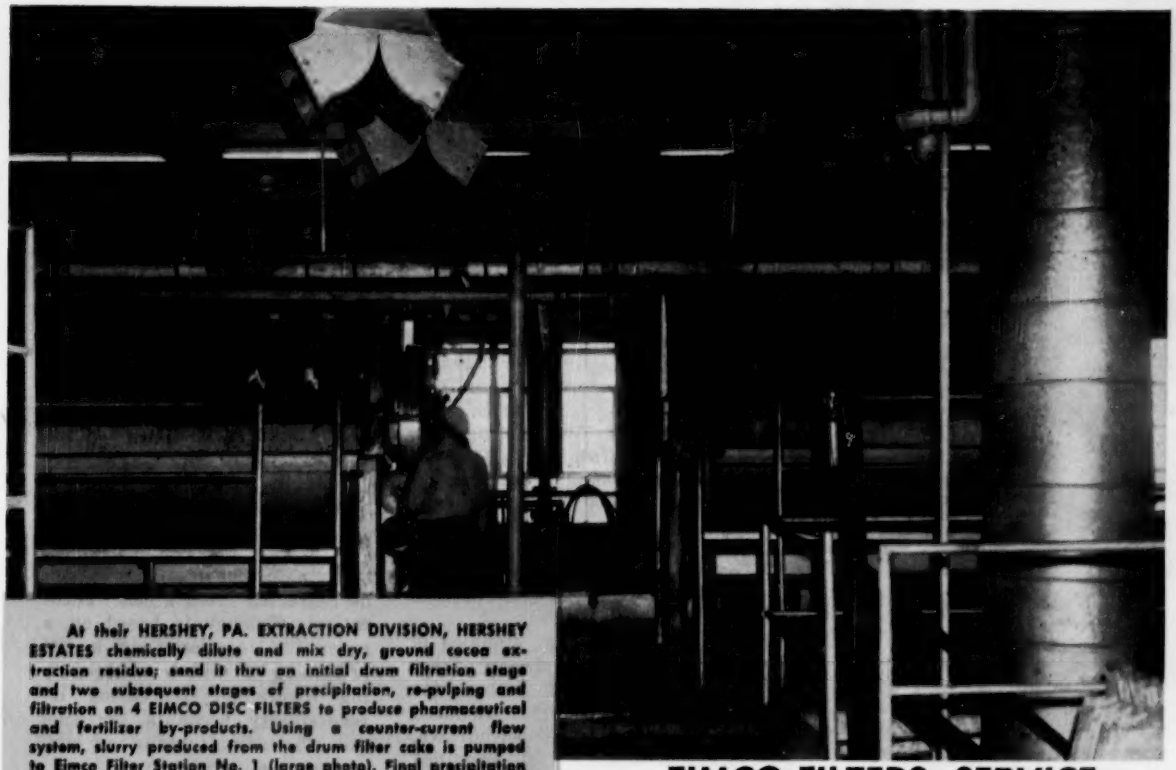
Cell operates at 0.5-1.0 v., 130 F. and atmospheric pressure. Efficiency ranges from 65-80%; voltage and efficiency fall as larger currents are withdrawn. Current capacity is proportional to size of cell. Desired combinations of current and voltage can be obtained by hooking different-sized cells in series (e.g., fuel cells supply "silent sentry" with 28-v. power).

▶ **More Power to Come**—Output of 1 kw./cu. ft. of cell volume can be boosted by increasing operating pressure, possibly up to 150 psi.; current output is directly proportional to pressure. Also, it is hoped research will up this rating.

Cell is not fussy about its fuel. Commercial-grade H_2 can be used, an improvement over previous H_2-O_2 cells.

Life expectancy of cell is unlimited; neither electrolyte nor electrodes are consumed during operation. A cell has been running at National Carbon's Parma, Ohio, lab for over a year with no signs of deterioration.

This cell cannot produce cheap power. But it produces silent, portable power that just suits the Army's needs for its "silent sentry" radar set. And fuel cell protagonists at the Electrochemical Society meeting felt that there were many such specialty needs that could be filled by fuel cells. After all, as one of them pointed out, electricity from



At their HERSHEY, PA. EXTRACTION DIVISION, HERSHEY ESTATES chemically dilute and mix dry, ground cocoa extraction residue; send it thru an initial drum filtration stage and two subsequent stages of precipitation, re-pulping and filtration on 4 EIMCO DISC FILTERS to produce pharmaceutical and fertilizer by-products. Using a counter-current flow system, slurry produced from the drum filter cake is pumped to Eimco Filter Station No. 1 (large photo). Final precipitation is gravity fed to Eimco Filter Station No. 2 (directly below), and the end-product is transported to storage on a continuous belt conveyor. Bottom photo shows closeup of Eimco Disc cake formation.

EIMCO FILTERS - SERVICE WIN HERSHEY'S CONFIDENCE

HERSHEY, PA. - Client confidence in Eimco filter equipment and service over a period of 15 years, is expressed by **Mr. H. B. Brewer,** operating manager of the **Extraction Division, Hershey Estates.**

In 1941 . it became feasible to add a two stage precipitation, re-pulping and disc filtration process to the flowsheet producing by-products from dry, ground cocoa extraction residue.

Mr. Brewer describes operation of two disc filter stations subsequently designed and installed by Eimco, "highly satisfactory. Over a 15 year period of around the clock operation, they have given us a dependable, efficient operation that has increased production and improved product quality."

This performance is a tribute to the durability and high mechanical operating efficiency of **Eimco** equipment and **Hershey's** intelligent maintenance program on a "planned" rather than "emergency" basis. From time to time, **Eimco** engineers and **Hershey** technologists have worked hand in hand to develop improvements to bring plant capacity to its present 90 tons of solids-per-day production.

The skills and experience that have won such lasting client confidence are at your disposal. Write today . . there's an Eimco Branch and Engineer in your vicinity.

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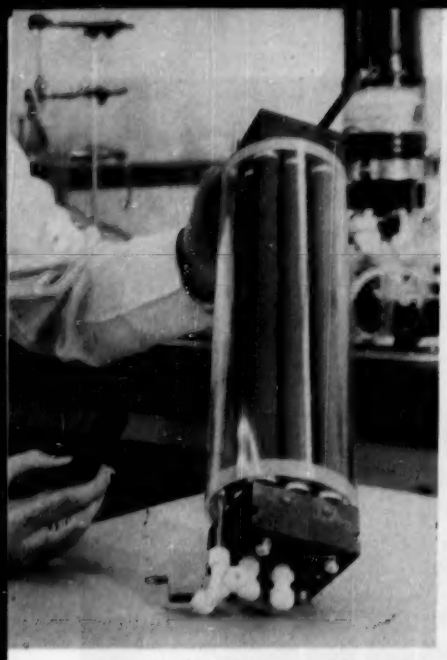


NINE electrodes form NCC's unit.

flashlight batteries costs about $50/kwh.

▶ **Bacon Cell**—Fuel cell's vast potential has led many organizations into fuel cell research.

Over in England, F. T. Bacon of Cambridge University's chemical engineering department has recently excited interest with his H_2-O_2 cell. Harnessing the same reaction as the National Carbon cell, Bacon's cell operates at 280-460 F. and 600-800 psi. It, too, uses a KOH electrolyte, but has porous nickel instead of carbon electrodes. A laboratory model delivered current at 0.8 v. with around 70% efficiency.

At operating conditions cell is rated at 3-4 kw./cu. ft. (At the same operating pressure, the National Carbon cell could presumably deliver in the order of 40 kw./cu. ft.)

Bacon is now working on design for a 10-kw. unit. No one has yet built a cell of this size; single cells to date have been fractions of a kilowatt.

▶ **Pitt-Consol Cell**—With an eye to advancing coal's place in this country's power picture, Pittsburgh Consolidation Coal Co. is pushing research to make fuel cell electricity competitive with steam-generated electricity.

Pitt-Consol's cell can "burn" carbon monoxide, as well as hydrogen, with air to give current at 0.5-0.9 v. Cell operates at 900-1,500 F. and uses a molten sodium-lithium carbonate electrolyte dispersed in a solid magnesium oxide matrix. Electrodes are semiconductive nickel oxide with "additives."

For greater over-all efficiency, cell might be placed inside a water-gas generator; heat from cell could help maintain the endothermic water-gas reaction. Pitt-Consol hopes for an over-all efficiency of 80%. A Pitt-Consol researcher expresses confidence that cell can eventually be made to operate on natural gas and other hydrocarbons.

▶ **Redox Cell**—And getting into the pre-laboratory stage, the "redox" cell has aroused some interest. Research has been conducted at University of London on a cell containing a permeable membrane between the electrodes to keep the cell reaction products separate.

Oxidized ion (e.g., stannic) is continuously withdrawn from cell, reduced with carbon (to stannous) and recycled. Reduced ion (e.g., bromide) is withdrawn, oxidized with air (to bromine) and recycled. So net consumption is external carbon and oxygen, but electricity comes from cell's redox reaction.

▶ **Thermo in Action**—Interest in fuel cells was originally aroused by comparing fuel cell thermodynamics with steam power generation. The fuel cell is inherently more efficient. Here's why:

When you use a heat cycle to generate power, you run into the limiting theoretical efficiency of the Carnot cycle. Even for advanced steam engines where the operating temperature is around 1,000 F., the ideal efficiency is only 70%. Friction and other losses whittle this figure down to 35% for the whole power-generating cycle.

▶ **Uses Free Energy**—Fuel cells—a special class of electrochemical cells—employ a different principle and are not held to such restrictions. Instead of using heat of combustion (ΔH) to heat a working fluid, a fuel cell uses free energy of chemical reaction (ΔF) to transfer electrons from regions of lower to higher potential at one electrode. These electrons are then allowed to "run down" through an external circuit and produce work.

For example, in the National Carbon cell, hydrogen diffuses to the surface of the H_2 electrode and reacts with the electrolyte:

$$H_2 + 2OH^- \rightarrow 2H_2O + 2\epsilon.$$

Electrons liberated at this electrode flow through an external circuit and return to the oxygen electrode, where two reactions take place;

$$2\epsilon + O_2 + H_2O \rightarrow OH^- + HO_2^-$$

$$HO_2^- \rightarrow \tfrac{1}{2}O_2 + OH^-$$

While the ΔH available in a heat cycle is restricted by the Carnot efficiency, theoretically 100% of the ΔF released in a fuel cell can be harnessed. For the H_2-O_2 reaction, ΔH and ΔF are almost identical; for some reactions, however, they differ considerably.

Of course, practical considerations limit the energy that can be extracted from a cell. Theoretical efficiency is based on a reversible reaction—and a cell producing current is not operating reversibly. Increasing irreversibility accounts for fuel cell efficiency dropping as current load is increased.

▶ **Fuel Cell Future**—This can be said for fuel cells with some certainty: Their use in specialty applications seems imminent. But use of fuel cells for large-volume electricity is still in the future.

Mentioned at the Electrochemical Society meeting were two specific instances where fuel cells might replace conventional batteries—reserve power for telephone systems and reserve for peak-load demand on electric railways.

Economic use of the H_2-O_2 cell depends on one key factor: cheap hydrogen. But right now, hydrogen is relatively expensive.

However, nuclear reactors are known to decompose water. Besides using atomic energy to boil water, therefore, reactors could also produce hydrogen and oxygen for fuel cell consumption.

Another possibility links fuel cells with solar energy. Main problem encountered with solar energy has been storage of energy for night-time use. Fuel cell proponents suggest using sun's energy to decompose water during the day. Fuel cells could then provide round-the-clock electricity.

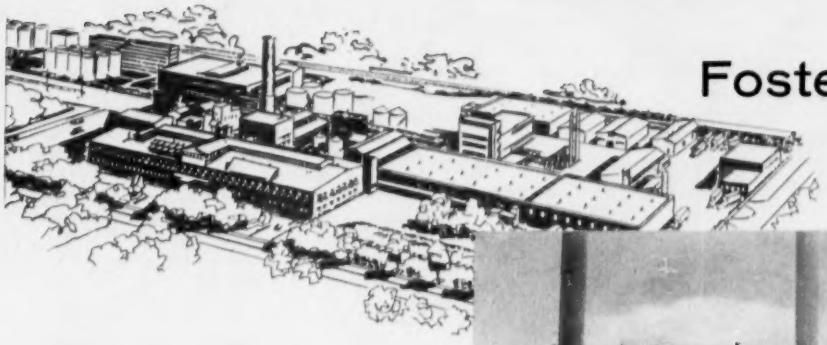
Fuel cells are best suited for direct-current users who can use

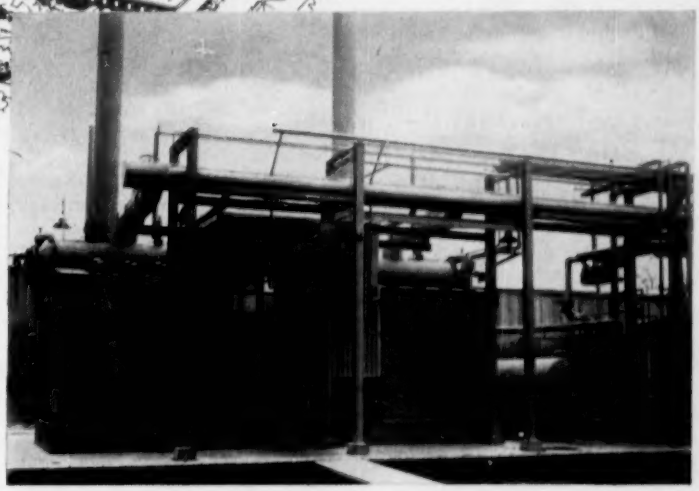
Another Major Food Processor Solves a

HOT PROBLEM with LOW-PRESSURE HEATING

by

Foster Wheeler





FW Vaporizers using Dowtherm keep steady 450 F temperature with only 6.5 psi Dowtherm pressure at Foods Division of Anderson, Clayton & Co.

THE Foods Division of Anderson, Clayton & Co., one of the largest producers of shortening, margarine and edible oils for the food industry, has found Dowtherm the ideal medium for process heating. In the deodorization of edible oils, heat was originally provided by 600 psi steam at 488 F or special, high flash point heating oils.

In contrast, the two FW vaporizers using Dowtherm, shown above, provide extremely accurate control, safer and more economical low-pressure piping arrangements and maximum flexibility for low-cost operation. Installed at the Sherman, Texas, Plant, each unit has an output of 4½ million Btu per hour and is used to heat bleached and hydrogenated oils in the vacuum still to 450 F with fraction-of-a-degree temperature control. The Dowtherm pressure in the heating coils is only 6.5 psi at 525 F.

On any process, Foster Wheeler offers the benefits of 23 years of experience in the design and application of heating systems using Dowtherm. Only Foster Wheeler does the *complete job*—designs and builds the vaporizer, installs it in the plant, puts it on stream and makes sure that everything functions at top efficiency. More information is available in Bulletin ID-54-5. *Write to Foster Wheeler Corporation, New York, N.Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

electricity right where it is produced. Electric railways and metal refiners (especially aluminum) are likely prospects if fuel cell economics can be solved.

Fuel cell electricity seems to be ruled out for public utilities because of need for alternating current. Losses in changing the low-voltage d.c. to high-voltage a.c. would cancel out much of fuel cell's advantage.

But where there's a need for portable power, reserve power or a small-volume power package where energy cost itself is not the only factor, prospects look bright for the fuel cell.

Plant Overhaul Fails to Bring in Necessary Profits

When it announced the shutdown of its Brownsville, Tex., plant recently, Amoco Chemicals Corp. told the story of a "world's first," a technical success but a financial disappointment.

This plant, originally constructed in 1950 by Carthage Hydrocol, represented the first commercial try at making synthetic gasoline and chemicals from natural gas. It was designed to convert natural gas (90 million cu. ft./day) and air (280 million cu. ft./day) into 6,000 bbl./day of gasoline, 900 bbl./day of diesel fuel, 200 bbl./day of fuel oil and 300,000 lb./day of chemicals.

In its short history, two companies have tried and failed to make this operation pay off. Plagued by process and mechanical difficulties in its first three years, the plant never topped a 30% operating status, and Carthage shut it down in 1953.

▶ **Rebuilt for Profit**—Shortly after that, Stanolind Oil & Gas Co. (now Pan American Petroleum Corp.) took over. Stanolind had contracted to buy the chemical raw materials, built a chemical recovery plant and stood to lose a lot if the Carthage plant were scrapped.

In every major step of the Hydrocol process, Stanolind revamped or built new equipment. Process involves controlled combustion of oxygen and natural gas to make a synthesis gas which is passed over iron catalyst in high-pressure reactors and converted to two basic product streams—chemicals and liquid fuels.

Stanolind completely reinsulated the 2,000-ton/day oxygen plant, repaired the gas generator and added a new one, modified the catalyst preparation system and reconditioned the reactors, adding internal catalyst cooling and a new catalyst filter system.

More changes were needed even while operations were under way. Finally, Amoco (the new owner through a series of name changes and the consolidation of Indiana Standard affiliates) announced in September that it was giving up. Even though most of the technical and operating problems had been solved, the plant never attained consistent on-stream performance necessary to profitable operations.

ICI Shutdown Laid to "Suspicious Public"

Whether because it was a new-fangled, man-made wool "substitute" or because it was made from peanuts, Britons didn't know, but they just wouldn't buy enough of it.

That, in essence, was one big reason that Imperial Chemical Industries closed up its Ardil peanut-protein fiber plant in Ayrshire. Public, and industry, too, were still highly suspicious of man-made fibers when ICI dubbed Ardil a "substitute." And, call them peanuts or "groundnuts" as Britishers do, it seemed a little far-fetched to be wearing clothes made of them.

So ICI shut down the six-year-old, 22-million-lb./yr. plant, and at the same time announced it would double production of tried-and-true Terylene at its Wilton works.

Too, ICI says it will introduce Terylene as a film under the name Melinex (similar to Du Pont's Mylar). Reportedly ICI plans a Melinex plant at Darwen in Lancashire. By doubling Terylene production, to 50 million lb./yr., the firm will be challenging nylon's lead (60 million lb./yr. in 1958) in the British man-made fiber field.

ICI has announced no further plans for groundnuts.

Convention Calendar

American Society of Mechanical Engineers, annual meeting, Statler Hotel, New York, N. Y., Dec. 1-6.

26th Exposition of Chemical Industries, Coliseum, New York, N. Y., Dec. 2-6.

Industrial Engineering Conference, Illinois Institute of Technology, Chicago, Ill., Dec. 5-6.

American Institute of Chemical Engineers, annual meeting, Conrad Hilton Hotel, Chicago, Ill., Dec. 8-11.

American Pharmaceutical Mfrs.' Assn., combined midyear and Eastern Section meeting, Waldorf-Astoria Hotel, New York, N. Y., Dec. 9-11.

Society of the Plastics Industry, Eighth SPI Film, Sheeting and Coated Fabrics Division conference, Commodore Hotel, New York, N. Y., Dec. 10-11.

Division of Industrial and Engineering Chemistry, ACS, Christmas symposium, Case Institute of Technology, Cleveland, Ohio, Jan. 2-3.

Ninth Plant Maintenance & Engineering Conference, concurrently with Plant Maintenance & Engineering Show, Hotel Palmer House and International Amphitheater, Chicago, Ill., Jan. 27-30.

Society of Plastics Engineers, 14th Annual National Technical and Engineering Conference, "Progress Through Plastics Engineering," Sheraton-Cadillac Hotel, Detroit, Mich., Jan. 28-31.

Instrument Society of America, national conference on progress and trends in chemical and petroleum instrumentation, Wilmington, Del., Feb. 3-4.

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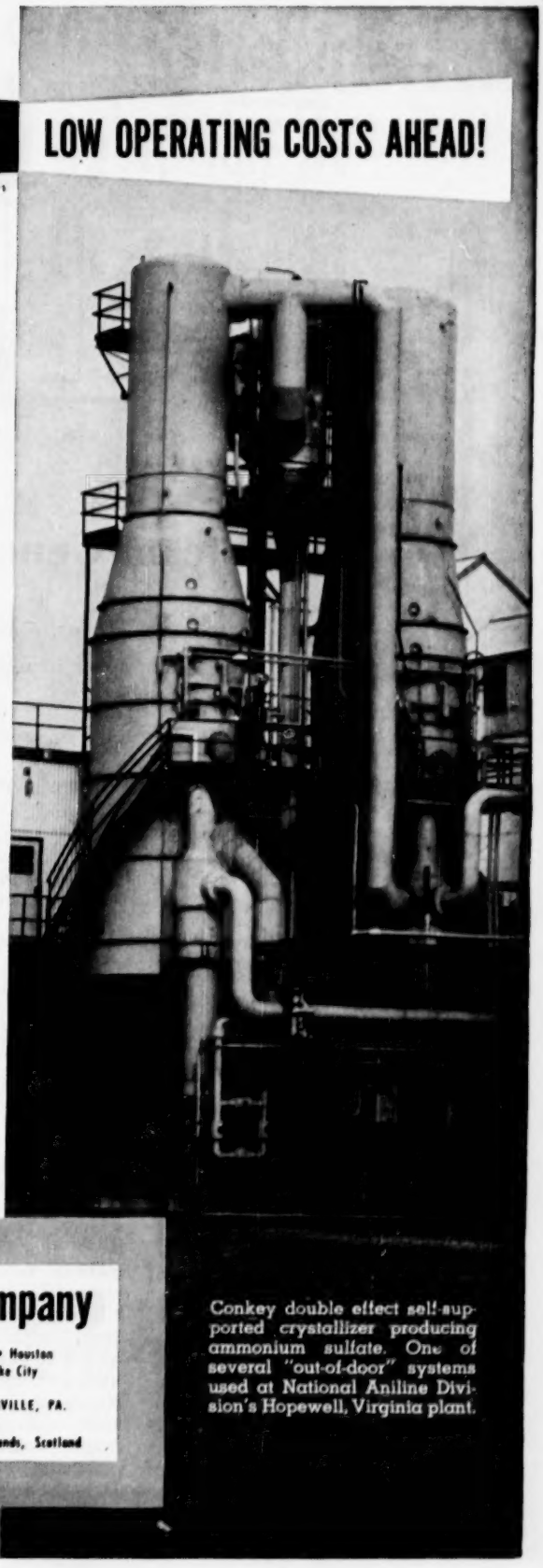
National Aniline Division

This double effect, evaporator crystallizer is used to produce crystalline ammonium sulfate and recover caprolactam monomer, raw material for Caprolan, (Allied Chemical's polyamide fiber) at National Aniline Division's Hopewell, Virginia plant. It is a completely self-supported structure—bubble tray column, vapor disengaging chamber, crystallizing chamber and support skirt are all assembled along the same center line.

Compact, unitized "out-of-door" construction such as this is another example of how Conkey "know-how" is helping progressive processors realize the benefits of low installation and erection costs and make maximum use of space. Optimum return for capacity, high crystal uniformity and characteristically low steam consumption provide maximum return on capital invested in Conkey systems.

Conkey crystallizers, for batch or continuous operation, are fabricated by CB&I in four strategically located, completely equipped plants. Laboratory facilities are available for pilot testing of samples. Write our nearest office for details.



Conkey double effect self-supported crystallizer producing ammonium sulfate. One of several "out-of-door" systems used at National Aniline Division's Hopewell, Virginia plant.

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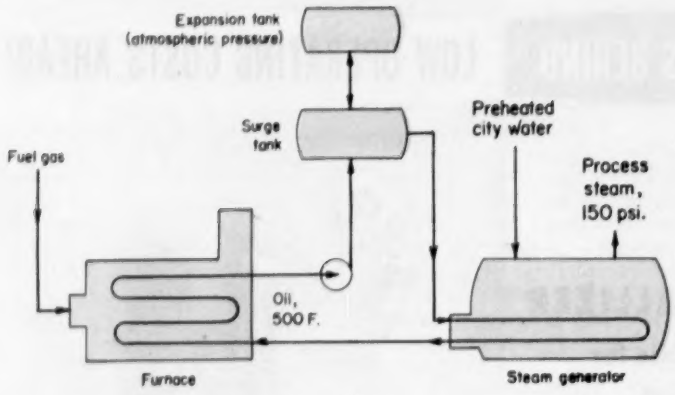

Two-Stage Steam Generator

- **Operates on untreated feed water.**
- **Delivers contamination-free steam.**
- **Permits simplified scale removal.**
- **Nets big cut in operating payroll.**

In the kitchen, boiling water is a cinch even for the tyro. But in the chemical plant, especially when it comes to cooking up steam for direct process use, it's an operation that can incite the ingenuity of a master chef.

At United States Durox' new gas concrete plant at Englewood, Colo. (*Chem. Eng.*, Nov. 1957, pp. 162-164), that's just what has happened. Teamed with consulting engineers Harmon and Beckett (Denver), Durox has come up with an unusual recipe for boiling water that appetizingly recommends itself to a variety of other chemical processing menus. It's a two-step steam-generating unit that raises the steam used by Durox to cure its output of gas concrete.

Essentially, here's what's involved: Rather than generate steam directly in a conventional fuel-fired boiler, Durox divides the job into two separate stages, with a heat-transfer medium in between. First, a simple gas-fired heater raises the temperature of a heavy oil to 500 F. This oil then passes through the tubes of a heat exchanger where water outside the tubes boils into 150-psig. steam.

▶**Chemical Treatment Taboo**—Why did Durox elect this indirect route? Answer stems from the fact that, with the steam brought in direct contact with the gas concrete product, Durox can't treat boiler feed water to prevent scaling. Here's why:

- To assure that there'll be no carryover of treating chemicals in the steam—chemicals that could contaminate the gas concrete—Durox can't use chemicals to treat the water.
- Because contact with gas concrete contaminates the steam condensate, Durox can't recycle it to the boiler. And this means that any other water-softening scheme (e.g., ion exchange) large enough to handle 100% makeup becomes an expensive proposition.

▶**Eases Scale Headaches**—Stuck with the scale, Durox makes it easier and cheaper to live with by taking the actual steam-generating step—and the scale—out of the furnace and into a separate heat exchanger.

Result: Periodic removal of scale is a considerably simpler task in the exchanger than in the guts of a furnace. For tube bundle can be readily removed and outside of tubes and inside wall of containing vessel easily cleaned. Moreover, Durox finds that scale builds up more slowly in the heat exchanger than in a furnace.

Maintenance and downtime savings, a company spokesman reports, outweigh the added expense of the more complex installation.

▶**Legal Loophole**—There's another persuasive reason for going to the two-part steam plant.

Since the gas-fired oil heater operates at less than 15 psig., it escapes Colorado boiler-code regulations. This means that Durox isn't required to have a licensed stationary engineer tending the installation.

Thus Durox sidesteps the cost of this high-priced function for the 24-hr./day steam plant, gets by instead with only one general maintenance worker. On this score, a company spokesman estimates, Durox reaps a $15,000/yr. payroll savings.

Consulting engineer Roy Harmon points out that many other chemical processors who face similar conditions as Durox could gainfully employ this unusual steam plant as well. By way of examples he cites such processes as direct steam injection, heat-treating plastics, rubber molding and curing prestressed concrete.

▶**How Steam Plant Runs**—A highly refined heat-transfer oil (fire point: 580 F.) feeds to a standard oil heater burning natural gas delivered at 3 psig. This unit, a type commonly used by highway builders to heat asphalt road oil, liberates 10 million Btu./hr. to heat the oil to 500 F.

From heater, oil is pumped through jacketed surge and expansion tanks, then flows through a 4-in. pipeline to the adjacent heat exchanger where the steam is generated.

Feed water, tapped from Denver's domestic supply, first goes through the jackets of the surge and expansion tanks. There, hot oil in the tanks preheats it from 60 to about 200 F. Then it passes through a cascade tank on its way to the heat exchanger tube bundle.

▶**Exchanger Design**—Heat ex-

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Cutaway view of Sharples P-7000 Vertical Super-D-Canter

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changer consists of a 14-ft.-long by 54-in.-dia. horizontal steel vessel, fitted with a bundle of U-tubes, 12 ft. long by 20 in. dia. providing 750 sq. ft. of heat-transfer surface.

About 14,000 cu. ft./hr. of 150-psig. saturated steam is produced. If steam pressure exceeds 150 psig., an automatic pressure switch opens an air-operated hydraulic valve in the oil line and the heated oil bypasses the heat exchanger, returns to the heater.

Steam travels via a 6-in. pipeline to the three autoclaves where gas concrete shapes are cured. Condensate goes to waste; heat-transfer oil recycles to the oil heater.

Intermittently the autoclaves have to be blown down. During this period the steam produced is diverted from the autoclaves to the cascade tank. There, instead of being wasted during blowdown, heat is recovered by boiler feed water entering exchanger.

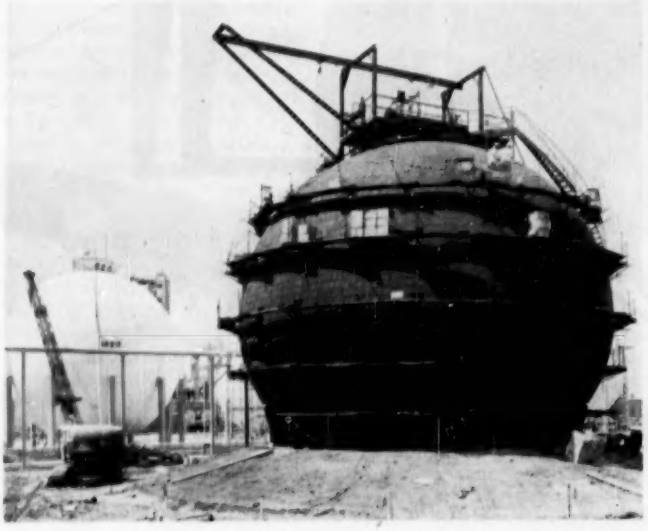
Paper Pulp Processed From Cotton Castoffs

Paper pulp from cotton and grape stalks: That's the goal of Kerncot Fiber Corp. in Buttonwillow, Calif. And it's leased a $3.5-million plant to carry out its plans.

The plant is in experimental operation now, is scheduled for full-scale operation by fall of 1958. When in full swing, it will turn out 150 tons/day of pulp.

Firm's raw material—cotton stalks and grapevine trimmings—will come from farms in surrounding Kern county, resulting in considerable saving in costs.

Process innovations are in the preliminary treatment of raw material. Cotton or grape stalks are fed to a Church Rotapulper and chopped into 1-in. pieces. These are soaked in an NaOH bath for a few hours. Subsequent defiberizing and processing are standard pulping operations.



LPG Storage Sphere Holds Constant 45 F.

Built-in refrigerator at the top of this storage tank at Esso Standard Oil Co.'s Baton Rouge, La., refinery keeps liquefied petroleum gas at a constant temperature of 45 F. Insulation for sphere is concave blocks of glass foam.

Energy From Coal Spurs Research in U. S., U. K.

Current research in the U. S. and Britain underscores renewed interest in coal as a source of chemicals and fuel when oil reserves become depleted or hard to get at.

Rock Springs, Wyo., will be the site of a $3-million coal-carbonization plant if Congress passes a bill to increase acreage of public coal lands that can be leased by a single firm. Union Pacific Coal Co. and Husky Oil Co. would construct the plant.

Carbonization of sub-bituminous coal, researched by UPCC and Bureau of Mines branch of coal technology, produces low-temperature tar and char. Tar is refined to recover chemicals. One report from Bureau of Mines describes carbonization as taking place at about 900 F. in a fluid-bed reactor, with a coal-particle residence time of 10-15 min. Fuels and chemicals produced are decomposition products, not synthetics.

Britain's Fuel Research Board reports promising improvements in Fischer-Tropsch conversion of coal to oil.

Process improvements and blossoming atomic power stations, says the Board, give hope of an economic, plentiful source of oil. There have been improvements in making synthesis gas; and suspending the catalyst in molten paraffin wax may prove to be cheaper than earlier techniques.

U. K.'s Greenwich Fuel Research Station has been probing effects of operating variables in small-scale reactors and a larger 50-gal./day pilot plant. Work has shown that with the new catalyst-in-wax technique, it's possible to convert 75% of synthesis gas to oily products. In one experiment, at 265 C. and 315 psi., 73.4% of liquid products boiled below 150 C.

Liquid-wax process still presents one problem: Finely divided forms of iron, a favorite Fischer-Tropsch catalyst, are unsuitable. So far, attempts have failed to make active catalysts on a large scale by chemical precipitation. Too, it's difficult to control temperature of the reacting gas within narrow limits.

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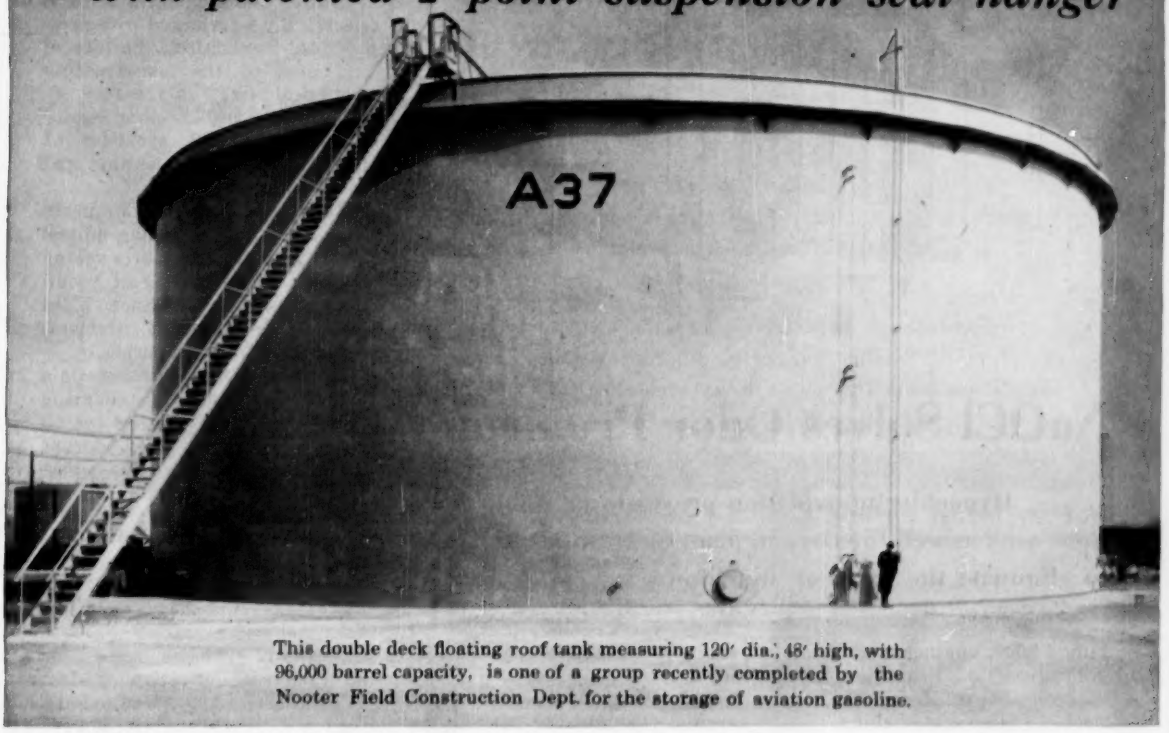
new floating roof tank

with patented 2-point suspension seal hanger



This double deck floating roof tank measuring 120′ dia., 48′ high, with 96,000 barrel capacity, is one of a group recently completed by the Nooter Field Construction Dept. for the storage of aviation gasoline.

The floating roof oil and gasoline storage tanks fabricated and erected by Nooter are now distinguished by the new patented Nooter seal.

Because this seal exerts a uniform outward pressure over the entire height of the sealing shoe, a better seal is achieved, and abrasion at any one point is reduced.

Another important feature of the seal: all operating mechanism is placed beneath the roof, leaving the deck clear and neat.

The Nooter seal is adaptable, without size limitation, to double-deck, pontoon and pan-type roofs, or any existing type of floating roof.

For complete information on how the new Nooter floating roof tank can serve you better, write or call Nooter today. No obligation.

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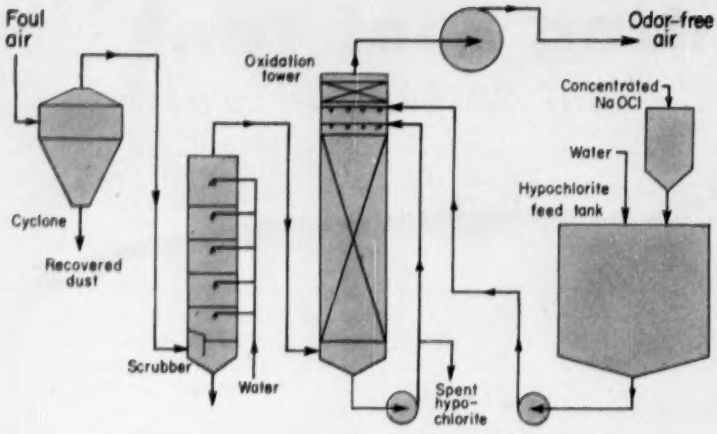

NaOCl Solves Odor Problem

Hypochlorite oxidation proves to be public relations asset as well for Oregon plant faced with ultimatum to eliminate the stink or shut down.

For an equipment outlay of only $4,000, engineers at Pacific Adhesives Co., Beaverton, Ore., claim to have licked an odor problem that was making their glue factory very unpopular.

Their solution: Oxidation of the offending gases with sodium hypochlorite in a simple packed tower. Although chlorine, calcium hypochlorite and chlorine dioxide have been occasionally used for industrial control of such odors (with varied success), use of NaOCl is believed to be novel.

More important, it got the plant out of an unpleasant situation pointed up by a court order which said in effect: "Clean up or get out!"

▶**Public in Arms**—Control of odor from plants processing animal material (Pacific Adhesives uses dried blood to make a plywood glue) has been receiving greater attention as the public becomes more militant about industrial pollution.

Four general methods are used to combat such odors—burning, chemical oxidation, adsorption and masking. Pacific Adhesives' engineers tried three of these methods and considered a fourth before arriving at a solution. Their experience provides a good example of applied smell-fighting.

▶**Kills Plant B. O.**—Here's the system that did the odor-killing trick for the 1-million-lb./yr. glue plant:

Foul air (100 cfm.) is collected from the odor-generating equipment by keeping it under slight negative pressure with a suction fan. A cyclone separator in the foul air stream traps and returns to the process most of the dust picked up by the suction. Foul air from the cyclone passes to a water scrubber, which removes the rest of the odorous dust.

Air then passes to a packed tower, where it is contacted with 25 gpm. of hypochlorite solution. Tower is mild steel lined with a polyvinyl chloride coating, 10 ft. high, 20 in. dia. and packed with ¾-in. Intalox saddles. Odor-free air is then exhausted to the atmosphere.

▶**Process Control** — Oxidizing solution contains 100 ppm. sodium hypochlorite at pH 4. Solution is somewhat unstable at this pH, but oxidizer is replenished batchwise every 2 hr. A float control automatically blends concentrated NaOCl and water when replenishing. Acidification is by hand. Since the oxidizing solution is quite corrosive, PVC piping is used throughout.

Entire odor-control system is electrically interlocked with process feed mechanism. Failure of any part of the odor-treating section shuts down the feed.

Installed cost of this equipment was $3,900, exclusive of electric motors. Operating cost is around $0.40/hr.

▶**No Blanket Cure**—Odor problems in plants processing animal materials are particularly vexing because of the variety of conditions encountered. Each plant presents a different problem; there is no single answer.

Burning of noxious odors is a widely used remedy in rendering plants. But some burner installations have encountered odorous materials which defy combustion. These odors discharge from the stack and plague the surrounding neighborhood. Too, burning can be expensive.

▶**Sometimes It Works** — Chemical oxidation, a cheaper remedy, has met with varied success. Chlorine dioxide is recognized as the most effective oxidant (*Chem. Eng.*, Apr. 1952, p. 174). And a U. S. patent (2,745,714) has recently been granted for a system for "deodorizing offensive organic odors" by treating with ClO_2.

However, a spokesman for Consolidated Rendering Co. states that its Syracuse, N. Y., plant has switched from ClO_2 oxidation to burning of plant odors. (Burner isn't entirely satisfactory either.) He notes that light volatile fat constituents are particularly resistant to chemical oxidation.

Calcium hypochlorite has been tried as an oxidant and found generally unsatisfactory. But Pacific Adhesives found that sodium hypochlorite solved its particular problem.

And as W. S. Gaiser, Pacific Adhesives' production engineer points out, "Much experimentation can be conducted for the price of one lawsuit."

▶**Glue Factory Blues**—Gaiser's statement is based on experience gained when the aroused citizenry of Beaverton declared war on the glue plant.

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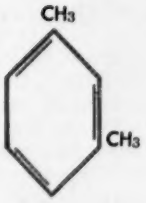
ORONITE® META-XYLENE 95%

commercial intermediate for making dyestuffs, polyesters, perfume ingredients!



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Dichlorination (boiling)	Meta-xylylene chloride	Hydrocarbon resin
Chlorination and hydrolysis	Meta-xylyl alcohol	Solvent, esters
Chlorination and hydrolysis	Meta-xylylene glycol	Alkyd resins
Chlorination (5% iodine, darkness, 0°C)	4-Chloro-meta-xylene	Solvent
Dichlorination	2, 4-Dichloro-meta-xylene	Insect repellent
Oxidation and Chlorination	Tetrachloroisophthalic acid	Non-flammable coatings and textile impregnants
Oxidation and Amidation	N, N— Diethyl-meta-toluamide	Insect repellent
Oxidation (chromyl chloride)	Meta-tolualdehyde	Perfume bases
Oxidation	Meta-phthalaldehyde	Dyestuffs synthesis
Sulfonation (oleum)	Meta-xylene-4-sulfonic acid	Dyestuffs
Sulfonation (fusion)	2, 4-Xylenol	Frothing agent
Chlorination and catalytic hydrolysis	3, 5-Xylenol	Phenolic resins
Acidic formaldehyde condensation	Meta-xylene formaldehyde resin	Paints and varnishes
Nitration (nitric and sulfuric acids)	4-Nitro-meta-xylene	Solvent
Nitration and reduction or hydroxylamine hydrochloride and $AlCl_3$	4-Amino-meta-xylene (meta-xylidine)	Dyestuffs
Dinitration (below 5° C with sulfuric (D 1.84) and nitric (D 1.51) acids)	2, 4-Dinitro-meta-xylene	Intermediate
Nitration (sulfuric and nitric acids)	2, 4, 6-Trinitro-meta-xylene	Explosive
Sulfonation (1 part meta-xylene at 150° C with 4 parts oleum)	Meta-xylene 4, 6-disulfonic acid	Intermediate
Sulfonation and fusion	Meta-xyloresorcinol	Resin accelerator
Acetylation (acetyl chloride in presence of $AlCl_3$)	Dimethyl acetophenone (4-meta-xylyl methyl ketone)	Perfume intermediate
Alkylation and dehydrogenation	2, 4-Dimethyl-styrene	Thermoplastic rubber

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in making the plywood adhesive creates an objectionable odor which formerly permeated nearby business and residential districts. The resulting hue and cry raised by plant's neighbors created poor public relations and eventually threatened plant's existence.

Glue process, a continuous operation, contains a "hot section" with heaters, grinders and conveyors which generate all the smell. Two types of effluent are given off—odorous particulate matter and foul gases.

▶ **What To Do?**—A water scrubber was installed in plant's exhaust system. This removed most of the odorous particles, but objectionable gases still passed through and offended neighboring noses.

Next, activated carbon cells were placed in the discharge from the water scrubber. These cells were quite effective when fresh, but rapidly became saturated.

Masking the smell with a counterodorant was tried. But it was difficult to control just the right amount of "perfume" in the exhaust. Complaints from irate citizens were just as vigorous when too much of the counterodorant was used as when too little was added.

▶ **Success at Last**—Odor-control research was spurred at this point by a threatening court order. Pacific Adhesives' engineers reappraised the situation.

First, a goal of total odor elimination was set; the sad state of public relations necessitated this ambitious goal. Two odor-killing methods were still untried—burning and chemical oxidation—masking and adsorption having been weighed and found wanting. Chemical oxidation was tried first because it offered a cheaper solution than burning.

Two oxidants were tested—sodium hypochlorite (laundry bleach) and chlorine dioxide. Results of laboratory tests: Both oxidants could eliminate the gaseous odors; chlorine dioxide was more effective on a weight basis than NaOCl; however, carryover odor of ClO_2 was higher.

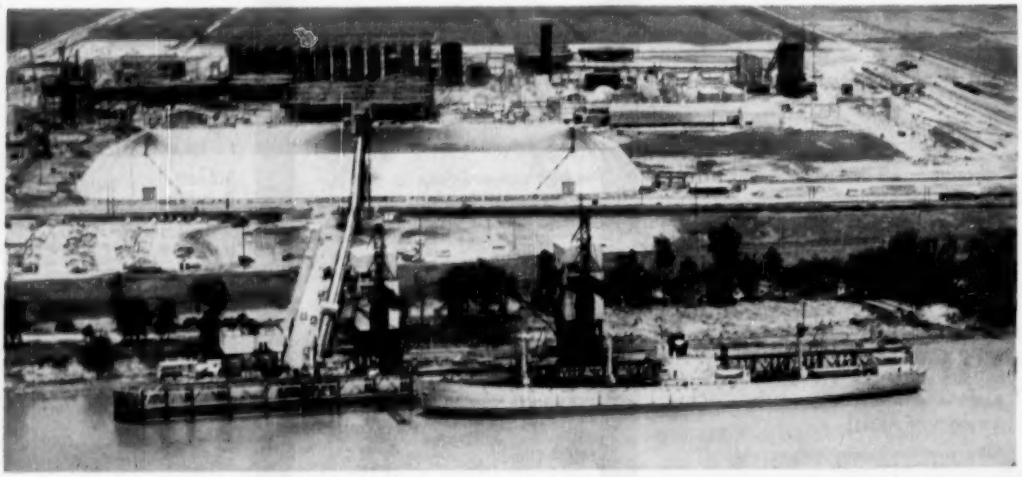
Three reasons dictated use of NaOCl for plant-scale operation: Lower cost of NaOCl on a performance basis, commercial availability of concentrated NaOCl solutions vs. necessity of generating ClO_2 on the spot, and NaOCl's lower carryover odor.

Phillips Petroleum Becomes U Producer

Phillips Petroleum Co. will become one of nation's largest producers of uranium concentrate when its new 1,725-ton/day uranium ore processing mill is completed in mid-1958.

Mill, located near Grants, N. M., will use the carbonate-leach process developed by Colorado School of Mines Research Foundation. Uranium complex is dissolved from the ore under heat in air-agitated vessels.

Construction is being handled by Western-Knapp Engineering Co. of San Francisco.



Bauxite Is Stored In Aluminum-Covered Building at New Alumina Plant

Shown above is unloading setup for shipment of bauxite at Kaiser Aluminum & Chemical Co.'s $70-million alumina plant at Gramercy, La. Ore is unshipped by mechanical unloaders, moved along covered conveyors to gigantic aluminum-covered storage building. Mud settlers, digesters and precipitators are shown in background. Ore is from Kaiser's mines in Jamaica, B. W. I.

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A fast-running, husky fire crew can pull it over jagged concrete, around sharp pillars—without any damage to it. Kinking or being run over does no harm. Even rats and termites can't chew it (believe it or not, over 600 feet of ordinary fire hose were eaten up last year in just *one* Texas plant). U. S. Matchless® has a special cord ply carcass made of "Ustex" fabric, resistant to rot and mildew. The white (or black) oil-proof neoprene cover resists oils, acids, fumes and strong, hot sunlight.

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- "Reliance" Double Jacket Dacron reinforced (weighs 54 lbs. per 100 ft.) (withstands 600 lbs. test pressure)

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*DuPont's trademark for its polyester fiber.

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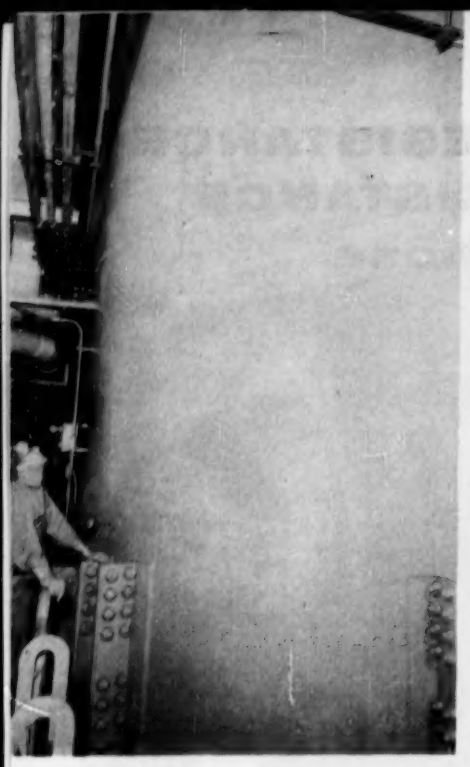


Yellow paint brushed over tank interior wall turns purple when ammonia seeps through tiny leaks from jacket.

Purple Dye Locates Disastrous Leaks

TAKE a look at the 30,000-gal. jacketed tank shown above—three stories high. There's a microscopic leak somewhere between the jacket and the tank interior. How do you find it?

This was no hypothetical problem—nor was the solution at all obvious—to Bristol Laboratories earlier this year. Two giant fermenters at its Syracuse, N. Y., plant were knocked out of production for about two weeks because of repeated—and mysterious—contamination by microorganisms which were traced to the cooling water flowing through jackets and coils.

After dogged searching with recommended methods, Bristol finally found the leak in the jacketed fermenter with a new and little-known chemical detection technique—the bromcresol purple method. It is extremely sensitive, economical and, like so many little-known things viewed with hindsight, remarkably simple.

▶ **Versatile Solution**—Moreover, this chemical method appears to be much more than a specific solution to a specific problem. It appears to be the most practical means of detecting many leaks in industrial equipment—even leaks which are of a size well within the sensitivity of older, more familiar techniques. For the chemical processor who never knows when, or even if, he will be plagued by obscure leaks, the bromcresol purple method looks like a natural.

As described at the recent American Chemical Society meeting in New York, Bristol used it this way: Pressurized the jacket with ammonia, then brushed a special bromcresol purple solution over the interior wall of the fermenter. Wherever ammonia could pass through the wall, the indicator paint changed dramatically from yellow to purple. It was as easy as that to find the leak.

▶ **Difficult Task**—Only it wasn't easy to find the method that found the leak. Bristol went to the literature, to firms like Eastman Kodak, Babcock & Wilcox, Linde, GE, Carrier, Walter Kidde, Chemico, Buffalo Tank.

The advice: Try methylene blue, fluorescent dyes, radioactive tracers, X-rays, ammonia-sulfur dioxide, halide torch, halide leak detector, helium mass spectrometer.

Bristol ruled out radioisotopes as too expensive, too tricky. Some chemical tests might leave toxic residuals to hamper subsequent fermentations. Background fluorescence from the fermenter's inner surfaces precluded putting this sort of dye in the jacket. Bristol couldn't obtain in short order a helium mass spectrometer small enough to get through the fermenter manhole (external testing requires high vacuum equipment and is not always conclusive).*

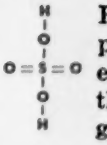
▶ **No Success**—So Bristol engineers tried methylene blue, SO_2 and NH_3, the halide testers. They could not find the leak. (Methylene blue did reveal the leak in the fermenter equipped with cooling coils. But only at 200 psi., and after banging the coils with a hammer and wiping the coil surfaces repeatedly with a clean white cloth.)

These failures were further confirmation of the minuteness of the leaks involved. The halide

* One manufacturer, Veeco Vacuum Corp., New Hyde Park, N. Y., has recently come out with a small portable unit.

Where lead gives useful corrosion control

in liquid Sulphur Dioxide process vessels and piping

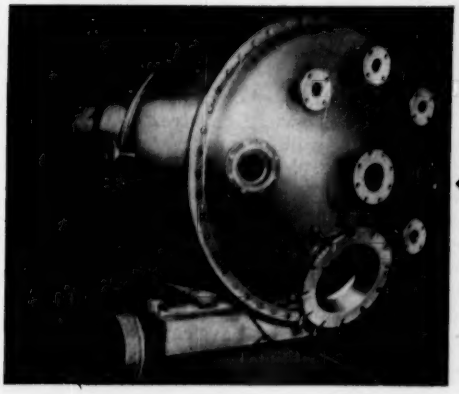


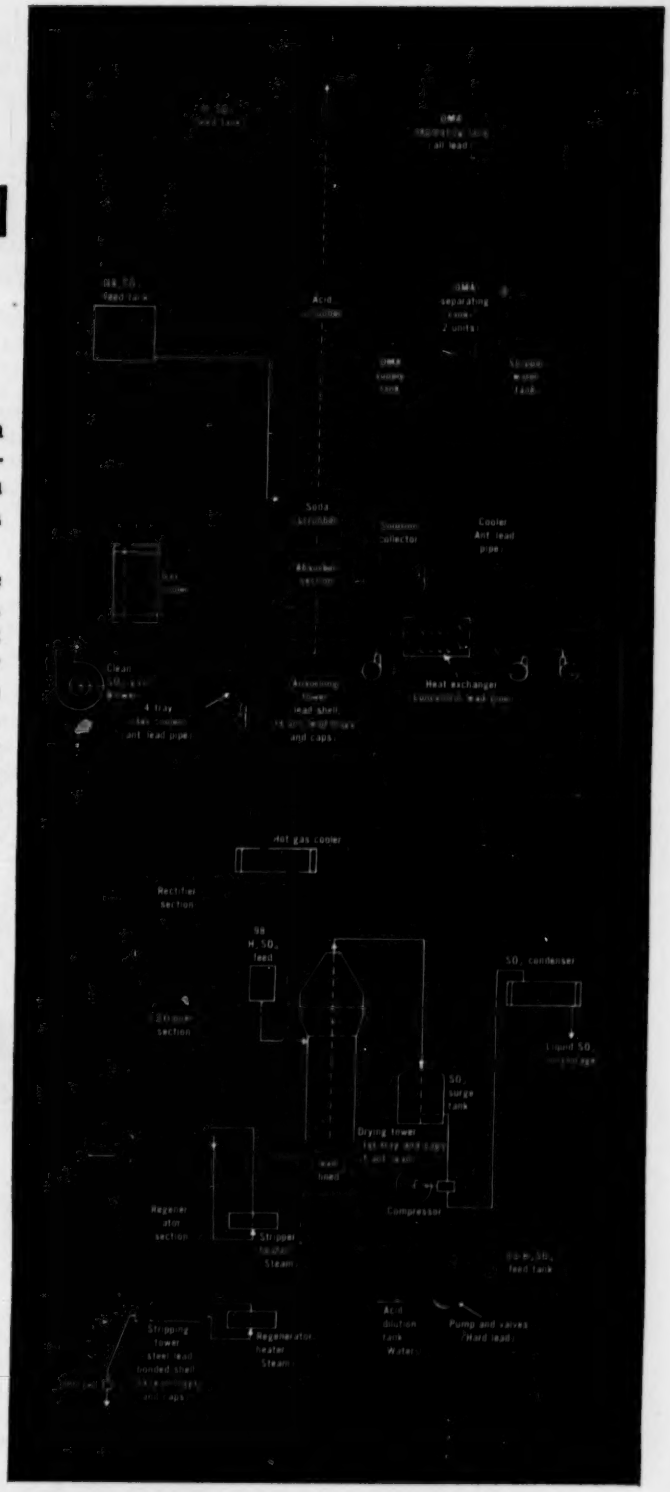
Hot SO_2 vapors and other oxidation products present in liquid SO_2 processing are "murder on metal." Even that old corrosive marauder, H_2SO_4 gets into the act.

As a result, *lead* practically lives with these acids and gases throughout the SO_2 process. In fact, the flow chart at the right is almost a continuous flow of *lead* applications. For ducts. For piping. For sheet lead linings in the larger units like the scrubbers and strippers. It is used with steel, with wood, with copper and, in some cases, with concrete. The result is low maintenance cost, facility of repair and consequent freedom from costly production stoppages.

If your process involves corrosive chemicals, look to *lead* for *long life, low maintenance and minimum loss of production due to down-time.*

When you think of Lead ...*think of* National Lead





National Lead has the experience to get *lead* and steel together in a *bond* that defies severe pressure and temperature changes, vibration and creep. That's been proved not only in regular production "stock" items such as piping and valves but also in specially designed, complex lead process and storage equipment.

If you are enlarging or modernizing your processing facilities, now's a good time to get the facts about lead-lined equipment. Contact National Lead Company, Lead Lined Products, 111 Broadway, New York 6, New York.

leak detector, for example, is rated as sensitive to a leakage rate of 70 cc./yr. Bristol knew, too, that even a few bacterial cells leaking into a sterile fermenter would show up in normal bacteriological tests.

▶ **Lucky Discovery** — Almost by accident Bristol came upon the means to the end. It learned that aircraft companies were using a bromcresol purple paint, supplied by Boeing Airplane, to check fuel tanks, structural vents and seals for leaks.

Bristol, to save time, made its own indicator formulation, brushed it on. About half way up the tank wall a vivid smear of purple disclosed a 3-ft. horizontal section of a seam weld as the area of leakage. The indicator paint was easily washed from the equipment and the seam rewelded and ground.

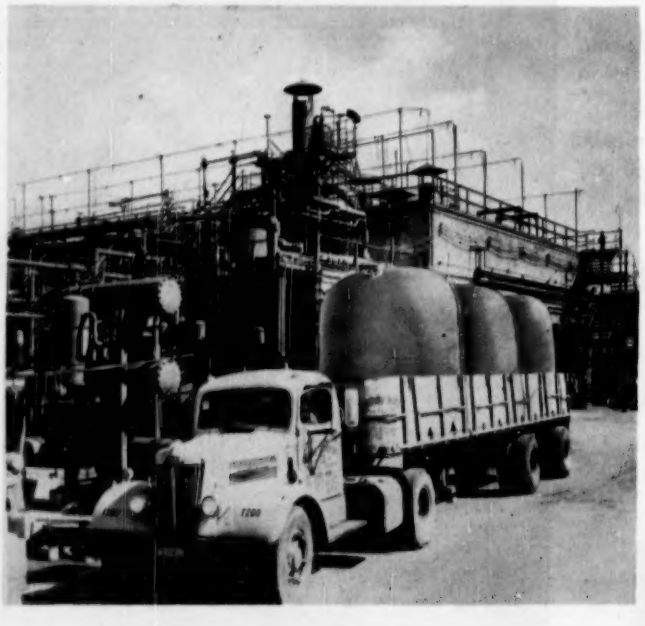
There's been no contamination in these fermenters since.

Continuous Sulfonation Gets Confidence Vote

Chemithon Corp.'s new unit for continuous hydrocarbon sulfonation (*Chem. Eng.*, Oct. 1957, p. 154) has received a vote of confidence in the marketplace. Colgate-Palmolive International has purchased a 20-million-lb./yr. sulfonation unit for installation at an Anzio, Italy, plant. Colgate is the first U. S. company to buy one of the Chemithon plants.

Unit will be used in manufacture of synthetic detergents.

Unit's capacity is four times that of the Seattle firm's three earlier units. Two of these were bought by Kao Soap Co. in Tokyo, Japan, and the third by Bunge Corp. of Sao Paulo, Brazil.



Zirconium Tetrachloride Rides in Rubber Bins

Loaded transport truck leaves Stauffer Chemical Co.'s Niagara Falls, N. Y., plant with a 30,000-lb. load of zirconium tetrachloride for National Distillers' new zirconium plant at Ashtabula, Ohio. Each rubber Seald-Bin holds 10,000 lb. of zirconium tetrachloride, blanketed inside with nitrogen. Empty rubber bins will be collapsed and shipped back to Niagara Falls.

News Briefs

Polyethylene: Du Pont, Union Carbide and National Petro-Chemical Corp. have all announced recent plans to build polyethylene plants. Du Pont will make linear poly at a site north of New Orleans; Carbide will build a 72-million-lb./yr. high-pressure poly plant at Whiting, Ind.; National Petro-Chemical plans a $20-million linear poly plant on the Houston Ship Channel.

Petroleum: Texas Co.'s new $15-million, 20,000-bbl./day refinery at Santiago de Cuba has begun operation. Refinery includes a gasoline treating unit, cat reformer, LPG unit and hydrotreater.

Boron: Borax Consolidated is building new research labs in Surrey, England, for research on all aspects of boron chemistry. New facilities, says the company, will go far beyond anything attempted in its present laboratories.

Aerosol antirusters: Rocket Chemical Co., San Diego, Calif., is now manufacturing, for the retail market, antirust compounds packed in aerosol spray cans.

Nuclear power: East Germany has started building its first 70-megawatt (heat) nuclear power station north of Berlin. Station is scheduled for completion in 1960.

Naval stores: Heyden Newport has swung on stream its new $3-million naval stores plant at Telogia, Fla. Plant is turning out FF-grade rosin, turpentine, pine oil and dipentene.

Lime: Chemical Lime Co.'s new $2-million lime plant is now in full operation near Baker, Ore. Two kilns have capacity of 72,000 tons/yr.

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TABER

FIG. 19,447

K-479

SERVING THE CHEMICAL INDUSTRY CONTINUOUSLY SINCE 1920 . . .

TABER has been and is being, confronted with a large variety of difficult pumping problems . . . some requiring immediate attention.

FAST ACTION. Inquiries often are processed thru our engineering and estimating departments, and our reply is on its way, in two working days. Next day service by mail or telephone is not unusual with Taber.

DETAILS. Strict attention to manufacturing and all other details is part of Taber's service. For example, in pump designing, accessibility to deep stuffing boxes is considered important. (Mechanical seals or conventional packing is supplied.) Shaft diameters are of extra large dimensions to prevent flexure, thus increasing mechanical life of the pump. Only high grade flexible couplings are used.

KNOW-HOW PROVED. Because Taber Pumps have performed above average, in both new and tried applications, some of the oldest, largest and most respected producers in the chemical industry have been active Taber customers for years.

INQUIRIES INVITED. So, whatever your specific needs in Vertical and Horizontal pumps, please know you have come to highly specialized, experienced, and very much interested people . . . when you direct your pump inquiry to Taber.

TABER PUMP CO.

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for handling
ALKALINE SOLUTIONS
ACIDS
SOLVENTS
(hazardous and toxic)
Organic and Inorganic

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PUMPS MADE OF
all castable and machinable metals and alloys, ranging from pure nickel, thru all alloys and down to cast iron.

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BUILT FOR VACUUM AND PRESSURE SERVICE

●

BULLETINS

Vertical Pump, V-837
Horizontal Pump, C-355

Service Bulletin S-146 may help you decide on type of pump needed to avoid costly misapplication. ANY or ALL these bulletins gladly sent on request, written on your business stationery.

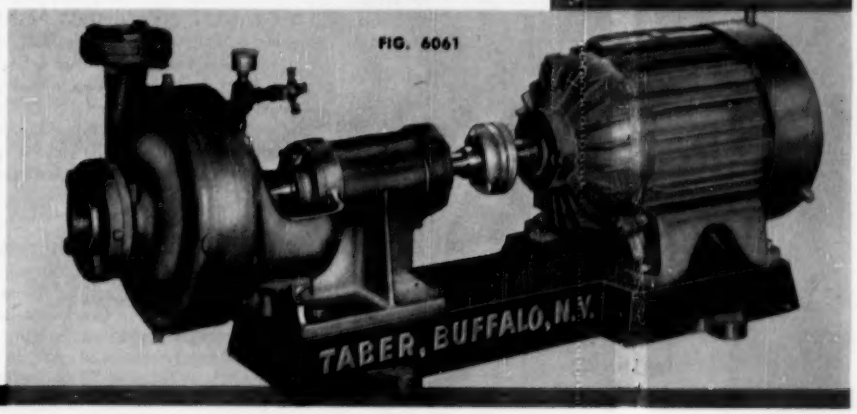


FIG. 6061

Life on the Chemical Newsfront

STRENGTH AND BEAUTY ARE ADDED TO SKIS made of FORMICA® *laminated plastics.* The typical hard, smooth surface adds to skiing speed. Exceptional resistance to heat and moisture keeps skis in top shape through many seasons of hard use. Special Cyanamid resins in FORMICA laminates give great impact and flexural strength to high-quality skis, golf club heads, paddle tennis racquets, and other sports items.
(The Formica Corporation)

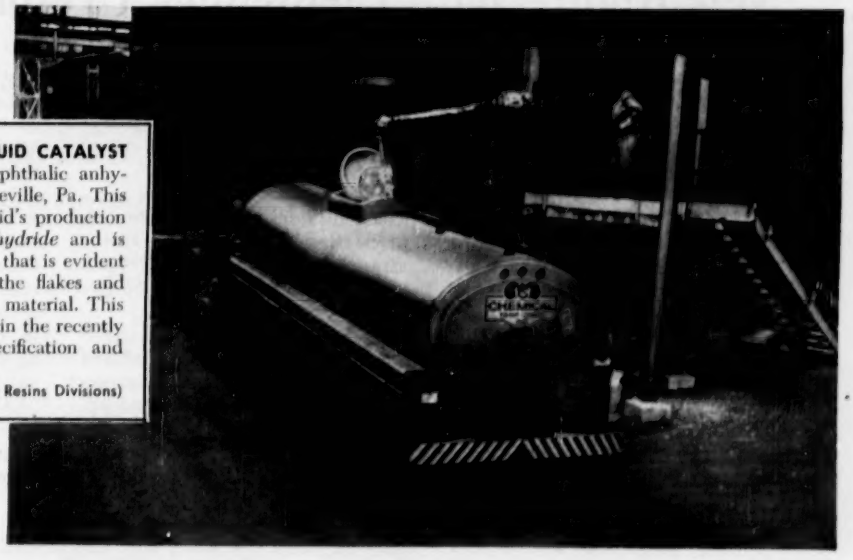
BETTER WATER-BASE PAINTS

THE EASIEST, PLEASANTEST PAINTING YET is the promise of paints made with new water-dispersed self-emulsified CYAQUA® *resin.* Combining virtually all the advantages of solvent-type alkyds and water-base latex paints, they brush easily, evenly and thoroughly, even over glossy surfaces. Missed spots – or "holidays" – can be touched up within minutes or hours without showing lap lines. Odor is pleasant, and brushes, rollers and spills can be rinsed easily with water. Touch-dry in minutes, CYAQUA resin-based paints withstand frequent scrubbing.
(Plastics and Resins Division)

A NEW, HIGHLY EFFICIENT THICKENING AGENT for all types of water-base paints is PAM 200 *polyacrylamide* – a new high-molecular weight grade of polyacrylamide only recently introduced. Unusually low concentrations of this water-soluble polymer are sufficient to give paints excellent spreading, leveling and pigment suspension properties. PAM 200 can be dissolved easily in cold water with conventional equipment without forming "fish eyes" of undispersed polymer. Warming does not affect its solubility. **(New Product Development Department)**

SEWING AND CUTTING ARE MADE EASIER in textiles finished with CYANATEX® 3130 *softener*. Fibers are lubricated and softened to give good drape and a soft, full "hand." CYANATEX 3130 is readily dispersed in water and may be used in conjunction with many other finishing agents in conventional process equipment. It is highly resistant to yellowing, free of odor, and does not affect fastness or shade of dyed fabrics. **(Organic Chemicals Division)**

ESSENTIAL TO BODY CELL PRODUCTION, *folic acid* is receiving increased attention as a nutritional supplement. Deficiencies lead to certain types of anemia—a danger particularly present during the highly increased cell production of pregnancy. Prenatal diets often call for folic acid in supplemental form to avoid blood abnormalities in both mother and child. Found in liver, yeast and leafy vegetables, folic acid is manufactured by Cyanamid for professional use and for the manufacture of multivitamin preparations.
(Fine Chemicals Division)



THE APPLICATION OF NEW FLUID CATALYST TECHNIQUES to production of phthalic anhydride is well under way at Bridgeville, Pa. This new plant has increased Cyanamid's production capacity for AERO® *phthalic anhydride* and is yielding an extremely pure grade that is evident from the unusual whiteness of the flakes and the brilliant clarity of the molten material. This new product quality is presented in the recently published Cyanamid "P.A." specification and typical properties.
(Industrial Chemicals and Plastics and Resins Divisions)

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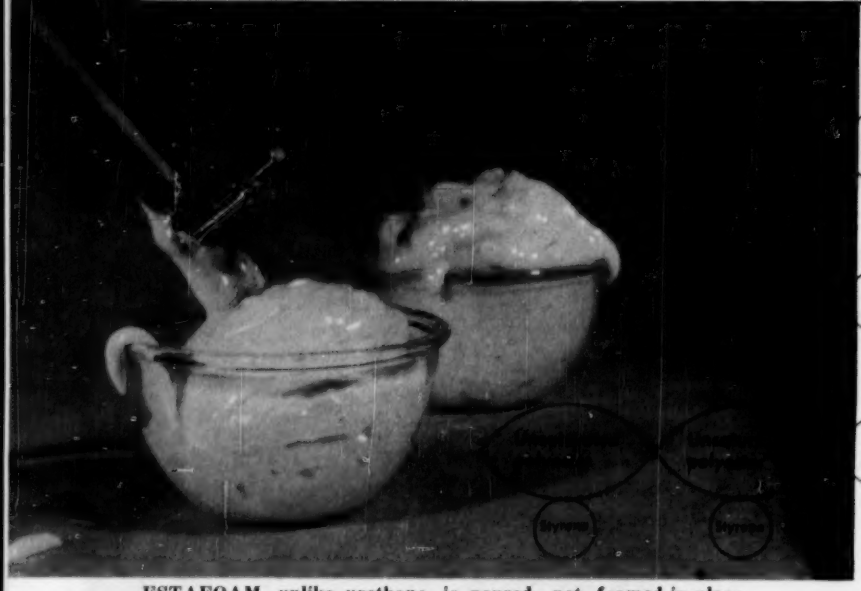
For further information on these and other chemicals, call, write or wire American Cyanamid Company



ESTAFOAM, unlike urethane, is poured—not foamed-in-place.

New Rigid Foam Challenges Urethane, Styrene

New unsaturated polyester foam offers properties on a par with urethane, price on a par with polystyrene, as magic combination to volume markets.

At 40-50¢/lb., the price tag on raw materials for new foamed unsaturated polyester, called Estafoam, puts it in the ball park with 52¢/lb. expandable polystyrene rather than urethane foam at 65¢ and up. The polystyrene product holds most of the existing rigid-foam market.

But both urethane and Estafoam have property advantages. These may substantially extend rigid foams' bailiwick, into structural applications, refrigeration, packaging where they will be in competition with such conventional materials as glass-fiber reinforced and insulated products.

Thermosetting urethane and Estafoam foams will not soften easily with heat like the thermoplastic polystyrene foams. Both (like polystyrene foam) have a closed cell structure. They have excellent and similar strength properties, i.e., compressive strength in the order of 100 psi. compared to polystyrene's 55 psi. for 6-lb./cu. ft. densities.

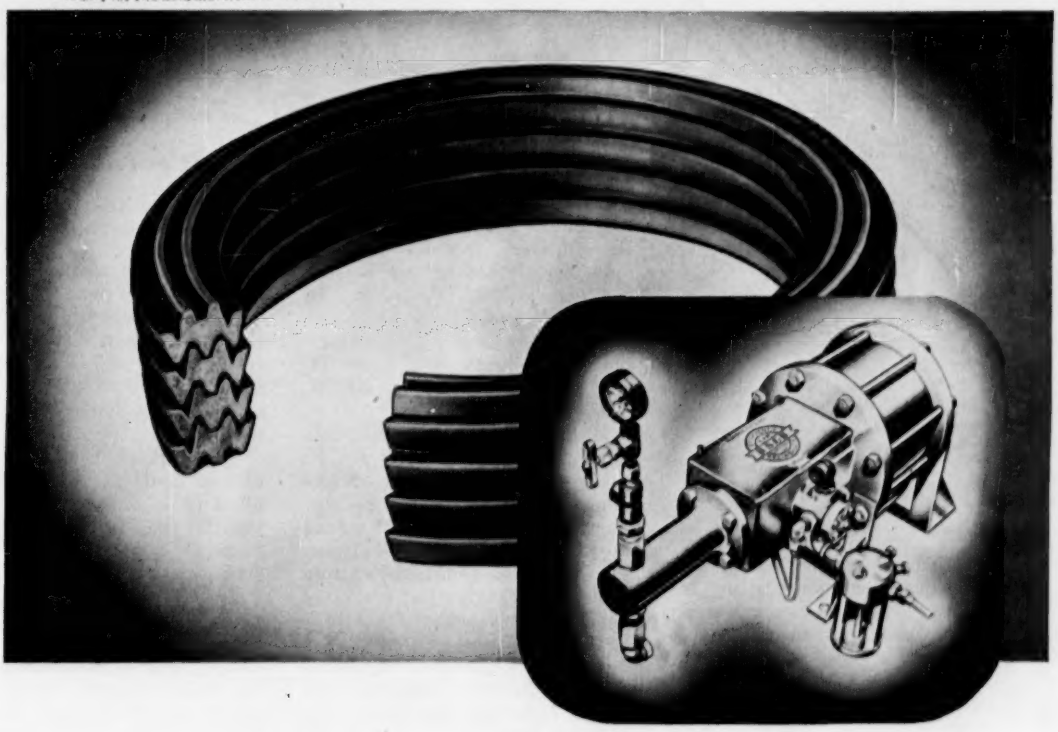
Because of Estafoam's excellent bonding properties and low shrinkage, sandwich constructions may be molded in one operation by foaming between two faces of plastic, plywood or aluminum. Urethane foams do not require adhesives either. But polystyrene does; this adds not only an extra operating step but also an adhesive cost to the tune of, say, 20¢/lb. for epoxy. (To compete with polystyrene on its own terms in present markets, a 2-lb./cu. ft. Estafoam is now in pilot plant.)

Besides price, Estafoam has a few other advantages over urethane foam. Estafoam is poured in place fully foamed, unlike urethanes which are foamed in place. Thus the relatively tricky control mechanisms needed to predetermine final urethane foam volume and density are eliminated with Estafoam. This is a particularly important point when filling narrow sections. Because, in the mold, urethanes are still undergoing a chemical reaction generating CO_2 gas which in turn creates foam, they are harder to handle in closed molds than Estafoams.

And HET acids, which produce the only polyesters approved by underwriters for fire resistance, may be used in the production of Estafoam; not so of urethanes.

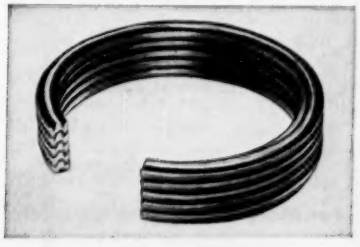
Estafoam's developer's, Vanguard Products, Newark, N. J., hope that price on a par with polystyrene and properties comparable to urethane may be the magic combination to a largely undeveloped rigid foam market: Domestic and commercial refrigeration, refrigerated trucks, flame resistant sandwich building panels, general insulation,

J-M Uneepac® does it again!



"Very satisfactory sealing service against wide variety of fluids and pressures up to 5,500 psi"

says Black, Sivalls and Bryson, Inc. makers of BS&B Glycol Pump



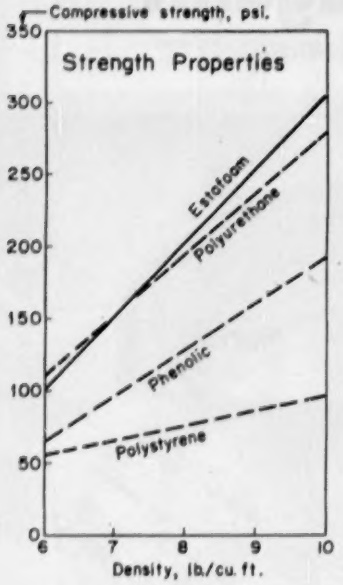
Uneepac comes in two types. Shown here is design for flange widths up to ½" which is used in BS&B Glycol Pump. Large illustration above shows design for flange widths over ½".

Chalk up another success story for Uneepac—Johns-Manville's automatic ring packing. In the BS&B Glycol Pump, fluids handled include triethylene glycol, diethylene glycol, gasoline, and various types of oils, alcohols and petroleum treating chemicals. Working pressures range from 125 psi to 5,500 psi with average operating pressures at 3,000 psi. Yet despite these rugged service conditions, Uneepac has delivered—in Black, Sivalls and Bryson's own words—"very satisfactory service."

Many other packing users have acclaimed J-M Uneepac for its long, trouble-free service. Each ring is a complete packing unit. Fewer rings are needed than ordinarily required and stuffing box size can be reduced to the minimum. Each ring centers itself automatically on the preceding ring to simplify installation. This exclusive design also permits fluid pressure to act upon each lip individually and protects lips from excessive gland pressure.

J-M Uneepac comes in a wide range of styles and sizes for many rod and plunger applications. For further information write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario

Johns-Manville PACKINGS, GASKETS and TEXTILES



pipe insulation, shock cushioning for delicate instruments and intricate parts in shipment.

Estafoam is essentially 100% unsaturated polyester. When a dibasic acid which contains a doubly bonded pair of carbon atoms is reacted with a dihydric alcohol, an unsaturated polyester is formed. The double bonds render the unsaturated polyester capable of subsequent cross-linking. A wide variety of raw materials are available to allow tailor made properties.

After dissolving in a polymerizable monomer, such as styrene, the monomer and unsaturated polyester copolymerize under the influence of peroxide catalysts. The reaction is exothermic and the heat evolved aids in speeding cure. A crude comparison between unsaturated polyesters and polyurethanes is that the unsaturated polyesters substitute styrene for isocyanate.

Patents are pending on Vanguard's foaming materials and process, which is based on the incorporation of a gas, such as air, in an unsaturated polyester blend by mechanical agitation. After release through a nozzle, the fully expanded catalyzed foam has the appearance of whipped cream. The stable froth is deposited in a mold or on a moving belt and is levelled by a doctor blade. After a time predetermined by quantity of catalyst, the foam solidifies.—**Vanguard Products, Newark, N. J.** 174A

Vanadium Chlorides

Vanadium trichloride and dichloride get pilot plant production.

Construction of a pilot plant to produce the anhydrous lower chlorides of vanadium, vanadium trichloride and dichloride, has been started. Company has produced VCl_3 and VCl_2 for many years on a laboratory scale. Products will soon be ready for marketing in 100-lb. lots.

Major use for these materials appears to be as catalysts in the petrochemical field. Many other uses are expected as production rises to the point where there can be cost reductions. Future prices should be in line with other catalysts of a similar nature.

The pilot unit will utilize a process developed at the company's Denver laboratory.—**Rocky Mountain Research, Inc., Denver, Colo.** 176A

Fast-Curing Phenolic

Has faster cure speed than any other one- or two-step phenolic.

Field testing and laboratory findings have indicated reductions in cure time of up to 50% with a new two-step, general-purpose phenolic called BMM-7000 Black 25. The graph above demonstrates that cure speed is faster than either the typical two-step or the fast one-step and increases with increasing mold temperature.

A wood-flour-filled compound with an unusually low fines content, the new phenolic is also said to offer a decided advantage where mold temperature is limited. For example, at 315 F., it cures as fast as the one-step molded at 335 F. or the two-step molded at a 365 F. temperature.

Contrary to what is usual with fast curing materials, it has an ideal balance of molding latitude and cure speed and allows faster mold closing. These advantages, plus shorter electronic preheating requirements combine to greatly reduce cycle time and increase production rates.—**Bakelite Co., 260 Madison Ave., New York 16, N. Y.** 176B

Metallic Coating

Seeing through metal improves visibility.

A deposited metallic coating can electrially heat windshields or helmet visors to prevent fogging. Or it can be used solely as an infrared reflector to reduce solar heating, to provide, for example, cooler cockpits in aircraft.

A vaporized, essentially metallized coating, it may be applied by a high-vacuum coater to: flat or pre-formed regular plate or fully tempered glass; stable polyester type plastics.

Panels coated with the new product, called Sierracote, can be formed into "wrap-around" shapes with a minimum of optical distortion and still not lose electrical continuity. The extremely thin vacuum coating (a few millionths of an inch) maintains its electrical properties in applications far beyond those of other materials.

In a typical anti-fogging application, the coating manufacturer supplies the plastic panel complete with leads for connecting to the aircraft power supply. Completed panel is made from a coated thin ply laminated to a thicker structural load-bearing ply, together with an interlayer of polyvinyl butyral which serves to protect the coating. A sensing element,

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about any item in this department, circle its code number on the

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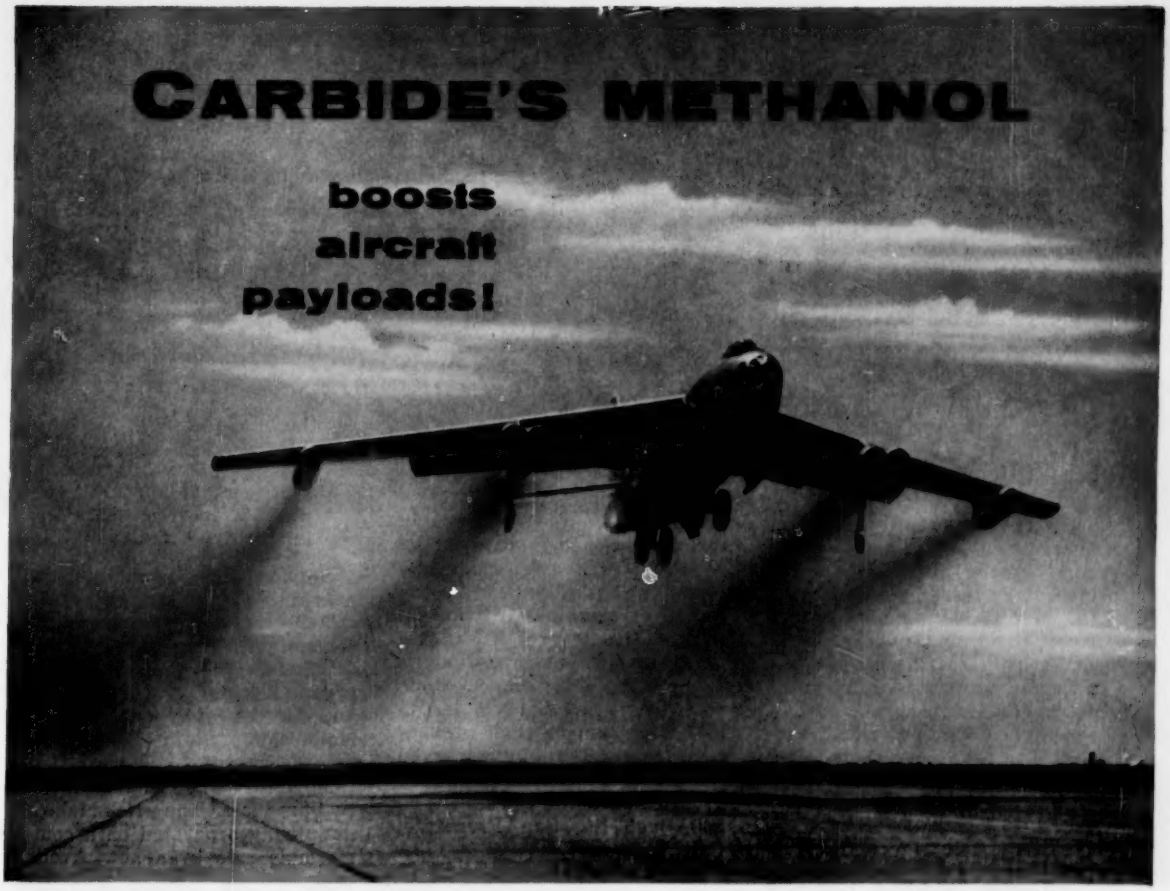
postcard inside the back cover



only one of many uses you can benefit from . . .

Added take-off power means higher payloads. And power output can be boosted for both modern turbo jets and conventional propeller engines. How? Simply by using an inexpensive methanol-water mixture, made from CARBIDE's methanol. In turbojets this mixture gives greater thrust and acceleration during take-off than jet fuel alone. Propeller engines gain 15 to 17 per cent horsepower.

But this is only one application of methanol—a few of the many other uses are as a solvent in the manufacture of vinyl acetate adhesives, aniline dyes, shellac, varnishes, wood stains, duplicating fluids and special printing inks.

CARBIDE's methanol is also used as a methylating agent for organic compounds, a raw material for formaldehyde, and an automobile anti-freeze base.

CARBIDE's Methanol is best for these and other uses because:

- Has a minimum purity of 99.85 per cent methanol by weight
- Can be shipped in: (1) 55 gallon drums in LCL or carload lots, (2) Compartment tank cars or tank trucks. And, tank cars range from 4,000 to 10,000 gallon capacity.
- Bulk stations are strategically located for your convenience

Ask the Technical Representative from Union Carbide Chemicals Company to tell you about these delivery services.

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For information on Methanol's uses and physical properties, write for technical information. Address: Union Carbide Chemicals Company, Room 328, Department M, 30 East 42nd Street, New York 17 New York. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Montreal.

"Union Carbide" is a registered trade-mark of Union Carbide Corporation.

Photo Courtesy of United States Air Force.

Newsworthy chemicals this month

New low-price, high-quality rigid foam...174A
Vanadium chlorides pilot planted.....176A
Faster cure speeds via new phenolic.....176B
Seeing through metal improves visibility..176C
New gelling agent for lubricants.....178A
Detergent-inhibitor upgrades lubes.....178B
Potato starch components available here..178C
Solvent-resistant fluorosilicone rubber....180A
GRS-mercaptan adducts.....180B
New butyl stands 400F.....180C
Another butyl passes truck tire tests.....180D
For tapes, silicone rubber gets stickiness..180E
One drop of adhesive supports 5,000 lb....182A

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installed on the surface or imbedded in the vinyl, automatically controls heat input.

Sierracote normally carries a heat output of one to two watts per square inch, although laboratory tests have indicated the coating has a much greater power-handling capacity.

When the coating is used as a reflector, it is possible to get up to 85% infrared reflection.—**Sierracin Corp., 903 North Victory Blvd., Burbank, Calif. 176C**

Gelling Agent

Grease additive improves lubricant performance.

A new synthetic gelling agent for industrial greases, Oronite GA-10, makes possible the formulation of superior multipurpose and specialized grease lubricants said to outperform the best of conventional greases.

A derivative of the miracle fiber ingredient, terephthalic acid, it was first developed by Oronite's research affiliate, California Research Corp., to meet the demand for grease lubricants that would stand up under the extreme temperatures, high loads and high speeds of modern machinery. Greases normally made with the sodium salt of the new GA-10 show remarkable heat stability, water resistance, work stability and bearing performance.

Compared to sodium stearate greases which have a dropping point between 375 and 425 F., sodium GA-10 greases maintain their structure up to 600 F. GA-10 grease showed no emulsification after a week in a boiling water test, whereas sodium stearate greases disintegrate in 4-5 min. Where water resistant grease lubricants are required, such as in materials handling equipment and construction machinery, the long life of GA-10 grease has reduced lubrication down-time as much as 95%. Lubricants made with GA-10 are said to last 2 to 3 times longer than conventional greases and it can take the place of several specialized greases.—**Oronite Chemical Co., 200 Bush St., San Francisco, Calif. 178A**

Detergent-Inhibitor

Upgrades automotive and diesel lubricants.

A versatile new type detergent-inhibitor, Paranox 302 is designed to give outstanding performance in both low temperature stop-and-go automotive service and high temperature diesel service.

It has been evaluated in numerous field tests encompassing over 2 million vehicle miles in a wide variety of equipment. In all these field tests, as well as laboratory engine tests, the outstanding performance reportedly has not been equaled by conventional type detergent-inhibitors or by the newest types of competitive additives.

Paranox 302 contains sulfur, phosphorous, zinc and barium. It is reported to provide protection against valve train wear and bearing corrosion at concentrations of 5.0 vol. % or more.—**Enjay Co., 15 West 51st St., New York, N. Y. 178B**

Amylose, Amylopectin

Both potato starch components are now marketed in the U. S.

Amylose and amylopectin, the principal components of potato starch, are being marketed in commercial quantities in the U. S.—amylose for the first time. Through an agreement with Avebe of Veendam, The Netherlands, Stein Hall has acquired exclusive sales rights in this country and Canada on the two products. The products are now being separated on a commercial scale by a new Avebe process.

Applications for amylose are still largely experimental. Possessing film forming properties, it is expected to find widespread use in the textile, paper coating and the biggest single potential appears to be in packaging films for foods and drugs.

Amylopectin, already being obtained from waxy maize or waxy sorghum, is used in textile sizing and finishing to stiffen and strengthen the fibers and prevent fuzziness. It is also used in paper sizing and coatings to strengthen the sheet and improve printability. In the food field, it goes into canned soups, and other products as a thickening and suspending agent.

The purified amylopectin obtained from potato starch by the Dutch process is expected to find markets similar to those of the corn products. Other uses may also be found for its greater reactivity—the result of breakdown of the granules during fractionation.—**Stein Hall & Co., 285 Madison Ave., New York, N. Y. 178C**

SOLVAY quality CAUSTIC POTASH

in types, forms and packages to fit your requirements

TECHNICAL GRADE

SOLVAY Technical Caustic Potash is the quality standard grade product that has been recognized by users as a leader in quality and dependability for over three decades. It is produced in both liquid and dry forms.

The dry product is produced in flake, small flake, walnut and solid forms, all of which are unusually low in iron, light in color and produce solutions of exceptional clarity. It is available in steel drums as follows:

Flake, 90-92%	350 lbs. net	(12-, 18-inch caps and full open head)
	100 lbs. net	
Small Flake, 90-92%	400 lbs. net	(12-, 18-inch caps and full open head)
	100 lbs. net	
Walnut, 90-92%	200 lbs. net	
	100 lbs. net	
Solid, 90-92%	675 lbs. net	
	100 lbs. net	

SOLVAY Technical Caustic Potash in liquid form is available in 45% strength in both returnable and non-returnable 55-gallon steel drums, 660 lbs. net, and in 45-52% strength in specially-lined tank cars of 4,000, 6,000, 8,000 and 10,000 gallons capacity.

MERCURY CELL GRADE

SOLVAY is the pioneer producer of this super-quality grade of commercial caustic potash. This material, which set a new standard for the industry for whiteness and purity, contains only trace quantities of metals and chloride, and is chlorate-free. It is available in both flake and liquid forms in the following packages:

Flake, 90-92%	Steel drums—350 lbs. net (15-inch cap and full open head)
	100 lbs. net
Liquor, 45%	Returnable 55-gal.—660 lbs. net
	Non-returnable 55-gal.—660 lbs. net
Liquor, 45-52%	Specially-lined tank cars—4,000, 6,000, 8,000 and 10,000 gallons

Mail coupon for complete data, sample!

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Aluminum Chloride • Vinyl Chloride • Sodium Nitrite
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Caustic Potash • Snowflake® Crystals • Caustic Soda
Sodium Bicarbonate • Ammonium Chloride • Chlorine
Methylene Chloride • Hydrogen Peroxide • Chloroform
Ammonium Bicarbonate • Monochlorobenzene • Cleaning Compounds • Ortho-dichlorobenzene • Para-dichlorobenzene
Methyl Chloride • Carbon Tetrachloride

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Please send me without cost:

Samples of Technical Grade Caustic Potash
☐ Flake ☐ Small Flake ☐ Solid ☐ Walnut
☐ Liquid, 45% strength ☐ Liquid, 49-50% strength

Samples of Mercury Cell Caustic Potash
☐ Flake ☐ Liquid

Caustic Potash fact book ☐

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Spate of Special Rubbers

- **For jet tires, silicones give high heat resistance.**
- **For tapes, silicones acquire stickiness.**
- **For truck tires, butyl now resists heat buildup.**
- **For mechanical goods, it can take a sustained 400 F.**
- **GRS gets new special-purpose properties.**

Evidence has been plentiful of late that rubber researchers are in the midst of a very busy season.

Butyl tire pictured above is an experimental one unveiled at the opening of U. S. Rubber's new research center in Wayne, N. J. Only a few months ago, officials of Army Ordnance announced that for the first time the Army's rigid tests had been passed by tires made wholly from a mass-produced synthetic rubber: butyl compounded by Esso Research & Engineering.

U. S. Rubber has announced an improved butyl compound called HTB which will stand sustained temperatures of 100 F. or more above other rubbers, including standard butyl. Reports are that superior heat resistance is due to a new nonsulfur cure.

The silicone tire shown above —body of silicone, cords of wire—is for aircraft designed for supersonic speeds. It resists 500 F., is a joint research effort of U. S. Rubber and Dow Corning. Other new developments in silicone rubbers:

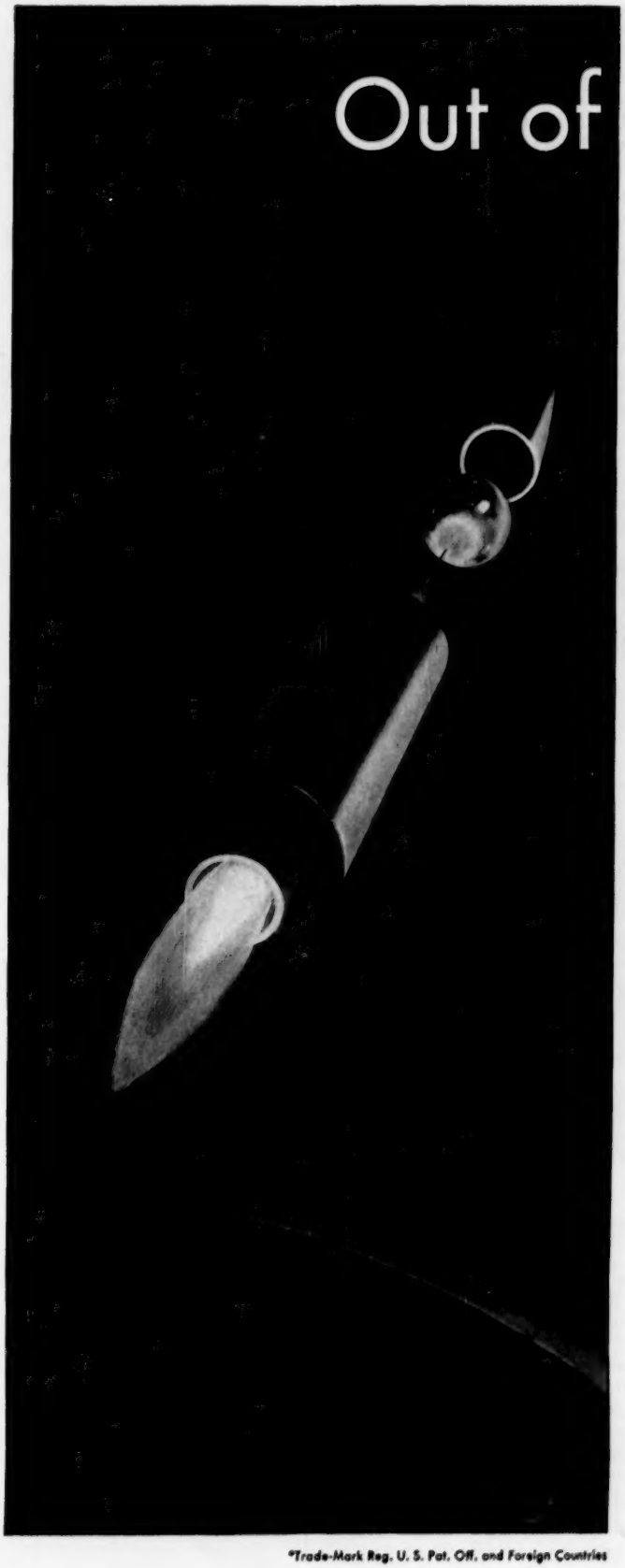
Union Carbide's Silicones Div. has come up with a new family of silicone rubber compounds with a reverse twist: built-in adhesive properties which suggest use in wrapping tapes for cables on ships and aircraft.

Dow Corning has a new fluorosilicone rubber said to produce maximum resistance to solvents, fuels, oils, at no expense to thermal stability, oxidation resistance or other properties characteristic of conventional silicone rubbers. Called Silastic LS-53, it is the result of cooperative research with Wright Air Development Cented.—**Dow Corning Corp., Midland, Mich. 180A**

THE VIBRATHANE tire in the photograph is U. S. Rubber's urethane rubber entry. Its billing: ". . . gives 200% more mileage than tires now in use." Also touted recently for long-wearing quality, General Tire & Rubber Co.'s new Genthane S urethane rubber (*Chem. Eng.*, Nov. 1957, p. 170).

A versatile new family of elastomers, described in recent research papers, are made by free radical addition of aliphatic mercaptans to the double bonds of diene polymers. By varying the ratio of the base polymer (standard styrene-butadiene), the mercaptan used, and the extent of saturation, a wide range of compositions and physical properties has been attained in the adducts. In general, resistance to aging, ozone attack, solvent swelling, heat, to permeation by gases and to gamma radiation increased with increasing saturation. Adducts with saturation levels up to about 85% can be cured with the same procedures used for base polymers Higher levels required activated or "butyl rubber type" curing systems.—**Goodyear Tire & Rubber Co., Akron, Ohio. 180B**

U. S. RUBBER'S HTB butyl will withstand a sustained temperature of 400 F. and a peak load of more than 700 F. for short periods of time. This compares with a maximum sustained heat resistance of only 250 F. for natural rubber, 275 F. for GR-S synthetic rubber and 300 F. for standard butyl rubber. Company is not selling the compound, but is utilizing it in the production

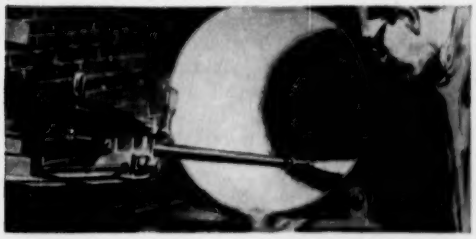


Out of this world!

Norton ROKIDE coating may aid in launching the satellite at the end of its final rocket ride — 300 miles high*

In the Defense Department's *Project Vanguard*, a three-stage rocket is planned to carry a shining satellite into an orbit hundreds of miles above the earth. The third and last stage of the rocket will reach approximately 18,000 miles per hour when it releases the satellite 300 miles above the earth.

One of the third-stage rocket engines being tested for Project Vanguard — and successfully flown last May 1st — was manufactured by The Grand Central Rocket Company of Redlands, California. To help contain the terrific



energy release required to reach this supersonic speed, the inside of its nozzle is protected with ROKIDE "A" aluminum oxide coating applied by the Metallizing Company of Los Angeles.

Besides ROKIDE "A" other Norton ROKIDE spray coatings include "ZS" zirconium silicate and "Z" zirconium oxide. All are hard, adherent crystalline refractory materials. All can be applied to base materials, particularly metals, of a wide variety of shapes and sizes.

Parts on which ROKIDE coatings are especially useful are those requiring thermal or electrical insulation . . . refractoriness . . . resistance to wear or corrosion . . . high melting points . . . excellent mechanical strength . . . dimensional stability . . . relative chemical inertness.

Proved in such critical applications as reaction motors and some A.E.C. projects, ROKIDE coatings are also of great value to general industry. Other Norton high-purity, chemically-stable refractory materials are helping industry to break through the "thermal barrier."

Facilities for applying ROKIDE coatings are available at Norton Company, Worcester, Mass., and Santa Clara, Cal., and at strategically located licensee plants. For complete facts, write to NORTON COMPANY, New Products Department, 803 New Bond Street, Worcester 6, Massachusetts.

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NEW PRODUCTS

Making better products . . . to make your products better

NORTON PRODUCTS
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BEHR-MANNING DIVISION
Coated Abrasives • Sharpening Stones
Pressure-Sensitive Tapes

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

of conveyor belts, hose and a variety of industrial molded products. It is also evaluating it as a possible tire rubber and for other automotive uses.—**U. S. Rubber Co., New York, N. Y.** 180C

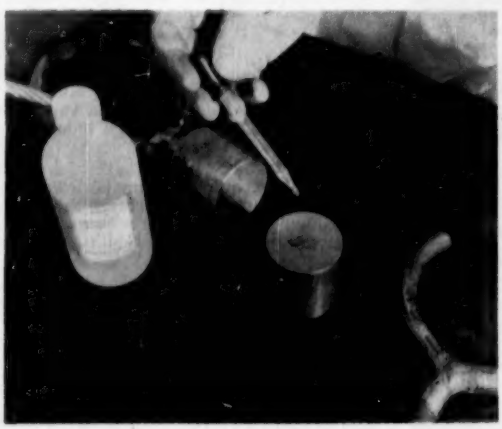
Esso's butyl was compounded with improved modifying agents which increase resiliency, result in lower heat generation. The latter has become a serious problem with both passenger and truck tires because of increased highway speeds and loadings. Ordnance tests show the new butyl tires to be at least equivalent or superior to military tires presently being made. (Butyl virtually eliminates ozone cracking and deterioration of truck tires.) Tires can be made on conventional equipment thanks to the development of a butyl latex dip. The latex permitted bonding of butyl rubber with tire cord.—**Pennsylvania Tire Co., Mansfield, Ohio; Esso Research & Engineering Co., New York, N. Y.** 180D

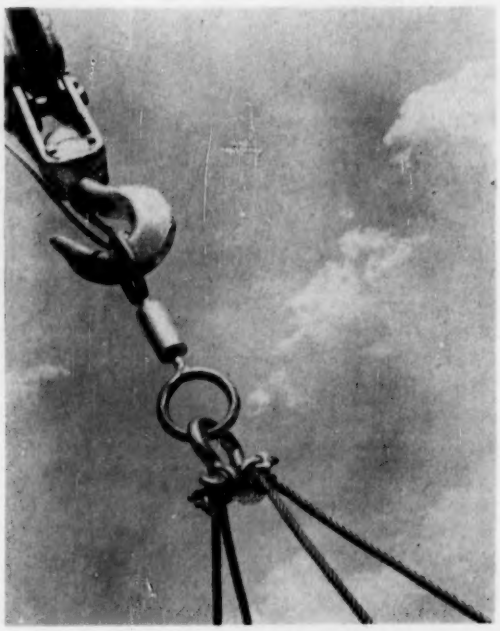
SILICONE rubber tapes, without any stickiness to the touch but which stick to themselves just by applying pressure can be made from a new, "fusible" silicone rubber. The fusible compounds represent a complete departure from the properties of conventional silicone rubbers, outstanding for their nonsticking qualities.

The new fusible silicone rubber compounds are said to provide building tack while maintaining the good physical and electrical properties inherent in the premium grade silicone compounds. They are defined as silicone rubber compounds, which, after any cure—even a full postcure—exhibit pressure sensitive surfaces. Even though the unique properties are attained by a basic modification in materials, the fusible compounds can still be cured with peroxide type catalysts.

Attempts have been made in the past to impart tack to silicone rubber by semi-curing a product or by adhesive-coating cured silicone rubber. Both of these methods meet the requirements by sacrificing properties in service to satisfy fabrication requirements.

One compound of the new silicone family is available to fabricators in limited quantities. It is Union Carbide K-1605 R, a general purpose insulating type. A second member of the series, which conducts electricity, has been developed and is scheduled to be soon in production.—**Silicones Div., Union Carbide Corp., New York, N. Y.** 180E





One Drop of Adhesive Supports 5,000 lb.

Within 30 min., a drop of new Eastman 910 adhesive placed between two 2-in. steel rods fitted with eye bolts will support a 5,000-lb car. Within 48 hr., it will support three such cars.

This is accomplished without heat, pressure, evaporation of solvent, or long curing times. Other high-strength adhesives require one or more of these conditions for successful bonding. Resulting from the polymerization of a cyanoacrylate monomer, the adhesive action works well with a wide variety of materials including metals, glass, wood, ceramics, rubber, plastics, cork, felt, leather, carboard and porcelain.

In very limited production, sample kits sell for $5 each.—Eastman Chemical Products, Inc., Kingsport, Tenn. 182A

New Mexican *Tri-Sure*® Plant

brings Tri-Sure® service to Mexico and Central America

New Tri-Sure Plant at Avenida No. 1 y Calle Piramide, Naucalpan, E. de Mexico, Mexico

Another link in the international chain of plants that comprises "Tri-Sure* the World Over," this modern new factory near Mexico City is producing Tri-Sure Seals, Plugs, Flanges, Nozzles and Caps—which give the contents of drums and pails positive protection from *leakage*, *seepage* and *contamination*.

The plant is strategically located to serve customers in Mexico and Central America, and to provide prompt sales-engineering service.

The newest of ten Tri-Sure plants, offices and affiliates, the Tri-Sure Mexican plant plays the important role of bringing to Latin American industry the protection of Tri-Sure Closures—the world's most widely *tested*, *approved* and *used* sealing device for steel shipping containers.

**The "Tri-Sure" Trademark is a mark of reliability backed by over 35 years serving industry.*

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Tri-Sure S/A Industria e Comercio, San Paulo, Brazil
American Flange & Manufacturing Co. Inc., Villawood, N. S. W., Australia
Compania Mexicana Tri-Sure S/A, Naucalpan, E. de Mexico, Mexico
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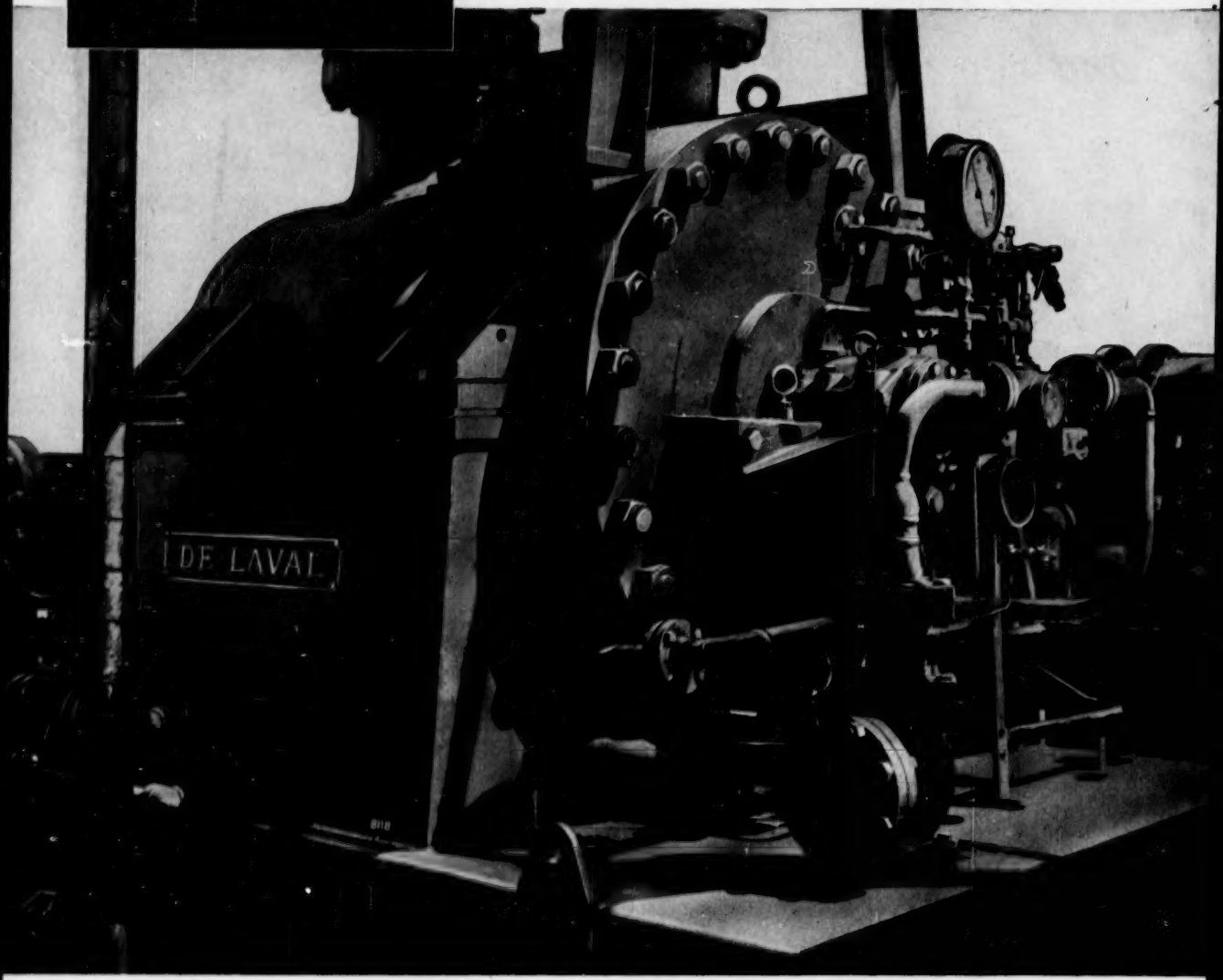
Always specify **Tri-Sure** *for every drum you ship*

CLOSURES

DE LAVAL

BARREL TYPE REFINERY COMPRESSOR

handles hydrogen under high pressures in a reformer at General Petroleum



Send for new Bulletin 0504

This De Laval centrifugal recycle barrel type compressor is doing a dependable job handling hydrogen under high pressures at the General Petroleum plant in Ferndale, Washington. It takes hydrogen at an inlet pressure of 500 psig and discharges it at 625 psig. The unit is driven by a 1110 hp turbine operating at 9900 rpm.

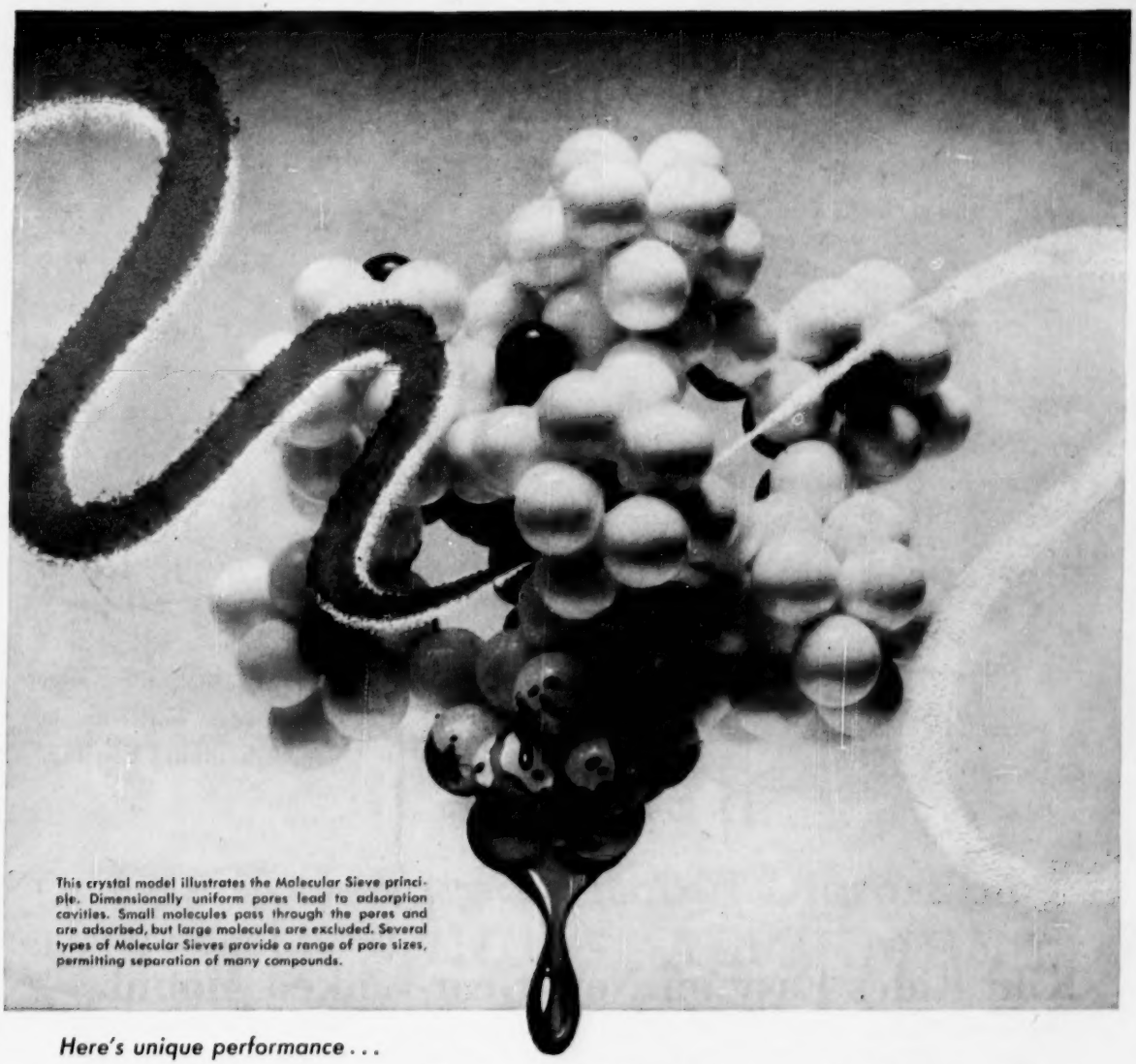
General Petroleum Corporation is only one of many refiners who have specified De Laval Compressors. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval. Rugged De Laval centrifugal compressors perform dependably in heavy-duty continuous operation. De Laval has more than 40 years of experience in solving gas compression problems.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

803 Nottingham Way, Trenton 2, New Jersey

BL-987



This crystal model illustrates the Molecular Sieve principle. Dimensionally uniform pores lead to adsorption cavities. Small molecules pass through the pores and are adsorbed, but large molecules are excluded. Several types of Molecular Sieves provide a range of pore sizes, permitting separation of many compounds.

Here's unique performance . . .

Molecular Sieves for Purification and Recovery!

. . . selective removal of contaminants, at temperatures up to 300°F!

. . . selective recovery of valuable stock without regard to relative boiling points!

Molecular Sieves, a new class of adsorbents developed by Linde Company, offer selective separation of gas or liquid mixtures in three ways . . . difference in molecule size . . . or polarity . . . or carbon bond saturation. And, co-adsorption can be utilized to remove several impurities simultaneously.

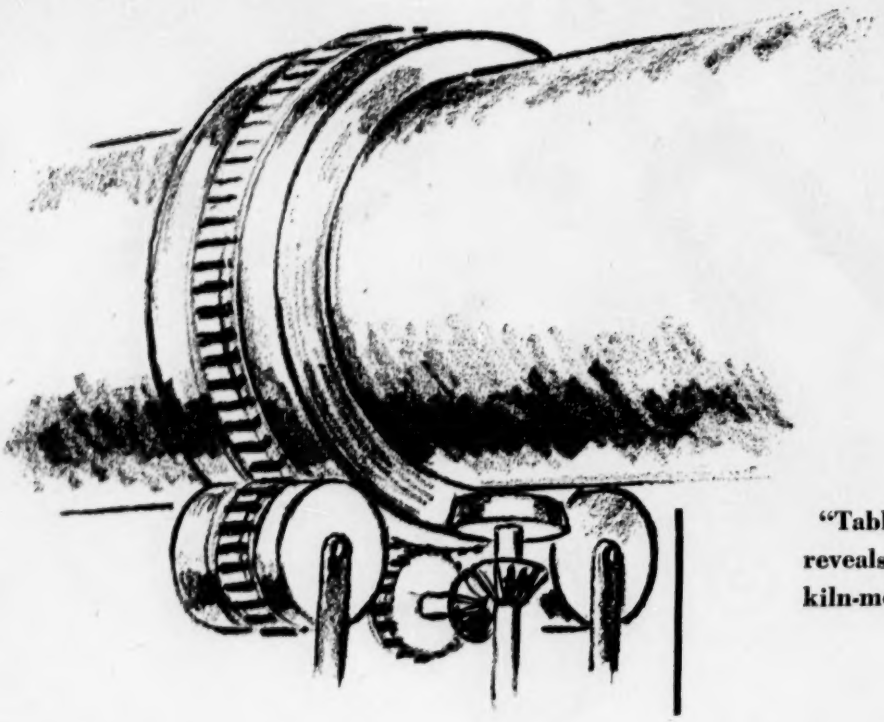
Typical uses? Removal of catalyst poisons from olefins . . . or extraction of olefins from refinery streams and top gases . . . or simultaneous dehydration and sweetening of natural gas . . . and many, many others.

LINDE Molecular Sieves offer new performance advantages . . . for many production uses. You may be able to lower costs, simplify processes, improve a product with this unique adsorbent. Find out more by writing for data describing Molecular Sieve properties and performance characteristics, Dept. CG-12, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

Linde TRADE MARK MOLECULAR SIEVES

UNION CARBIDE



"Table-top" sketch reveals works inside kiln-mount housing.

Kiln Rides Easy on New Gear-Linked Mount

Fabricated, accurately machined running gear eliminates frictional driving forces and wear, permits forced-feed lubrication on all bearing surfaces.

Breaking sharply with tradition, Vulcan Iron Works' new kiln links all its trunnion and thrust rollers to girth gears, cancelling out dependence on friction to move these rollers. Through such linkage, all rotating parts are synchronized to rotate simultaneously without slippage.

Design consolidates running-gear components, reduces number of supporting piers and cuts cost. Heavy castings have been replaced largely by strong, lightweight fabricated parts machined to close tolerances. All are enclosed within sealed housings.

Because mountings are enclosed and trunnion and thrust rollers are not friction driven, all gear teeth and bearing surfaces may be lubricated by forced feed. Under such conditions, frictional wear between tire and trunnion rollers becomes virtually non-existent, extending life of these elements indefinitely.

▶ **Inside Housing**—Within the sealed drive housing at the feed end of the kiln are two kiln tires or riding rings and the related trunnion rollers on which they ride; the kiln girth gear and its driving pinion; the kiln thrust tire or ring and the thrust roller against which it rides; the supporting base.

▶ **Look at Parts**—Kiln shell at this point is a double-walled weldment, on which is mounted a girth gear flanked by forged steel tires.

Tires ride on two trunnion rollers positioned on opposite sides of the kiln centerline. Rollers are mounted in base weldment which is supported by a conventional concrete pier or footing.

Each trunnion roller has two bearing surfaces to coincide with the position of the two tires. Between these two surfaces is a pinion gear that meshes with the girth gear.

Kiln is rotated by a suitable driver coupled to the shaft of

Easily Serviced without Disturbing PIPING—WIRING—ALIGNMENT

The complete drive unit, including the impeller, of this new Type SZ LaBour pump is removable as a unit for replacement or maintenance—leaving piping and motor undisturbed and in perfect alignment.

Although Type SZ is a non-priming pump, its design permits it to handle large quantities of air or gases mixed with the liquid, so that aerated solutions or volatile materials—within reasonable limits—cause no trouble whatever. The fully open impeller and absence of sealing rings or other closely fitted pumping parts give this pump the ability to move dirty liquids without clogging or loss of efficiency.

LaBour dependability, long the recognized top in the industry, is built into this newest LaBour unit. Practically any requirement as to corrosion-resistant materials can be met.

Full particulars are yours for the asking. Why not write today?

LABOUR

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Pulverizing Mill....190A

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one of the trunnion rollers. Motion is transmitted by pinion gear directly to girth gear, which in turn drives pinion on other trunnion roller.

▶ **Thrust Roller**—In the middle of base weldment, directly under the centerline of kiln, is located the thrust-roller mechanism. Roller is mounted on a vertical shaft, is beveled so that constant conjugate action exists between roller and riding ring over the entire face of loaded roller.

Gear linkage with girth gear assures positive synchronous rotation with thrust riding ring.

▶ **Downhill Duplicate**—Support for the kiln at the downhill or firing end duplicates the feed-end unit just described, except for two differences. There is no thrust mechanism. And there is no drive motor.

However, girth gear, tires, pinions and trunnion rollers are all there. Gear linkage synchronizes rotation of trunnion rollers with kiln, eliminating friction drive as mentioned previously.

If kiln is sufficiently long (300-400 ft.), an identical additional support may be needed between the two end stations.

▶ **No Break-in**—From initial startup, this design is expected to run easily without need for tedious break-in and adjustments. During construction, parts are machined to fit precisely. Then in the erection stage, once base weldments are located properly and anchored to the footings, all other parts drop into place so that kiln rides perfectly aligned on its trunnions.

Vulcan has completed tooling for this new design and is now ready to start manufacture.—**Vulcan Iron Works, Wilkes Barre, Pa.** 186A

Equipment Cost Index

	June 1957	Sept. 1957
Industry		
Avg. of all	224.1	225.0
Process Industries		
Cement mfg	215.3	216.6
Chemical	225.5	226.6
Clay products	209.2	210.4
Glass mfg	213.0	214.0
Paint mfg	216.6	217.4
Paper mfg	217.3	218.3
Petroleum ind	221.1	222.0
Rubber nd	223.9	224.8
Process ind. avg	222.8	223.7
Related Industries		
Elec. power equip	228.4	229.8
Mining, milling	226.9	228.0
Refrigerating	253.0	254.0
Steam power	212.0	212.8

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; March 1957, pp. 266-7 for annual averages since 1913.

Oil Heater

Heats transfer oils up to 600 F.

A new direct-fired oil heater heats transfer oils or other liquids up to 600 F. Main applications for unit are in the asphalt, chemical, plastic, oil refining and textile industries.

Design of the internal circulation forces the oil to flow at high velocity over the heating surfaces. Result is uniform oil temperature which eliminates hot spots, coking or deterioration of the transfer oil.

Fire-tested at the factory, unit is complete with removable heater element, integral forced draft fan and burner, and all necessary operating and safety controls. Heater is used with an expansion tank and external circulating set.—**Cleaver-Brooks Co., 326 East Keefe Ave., Milwaukee 12, Wis.** 188A

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about any item in this department, circle its code number on the

Reader Service

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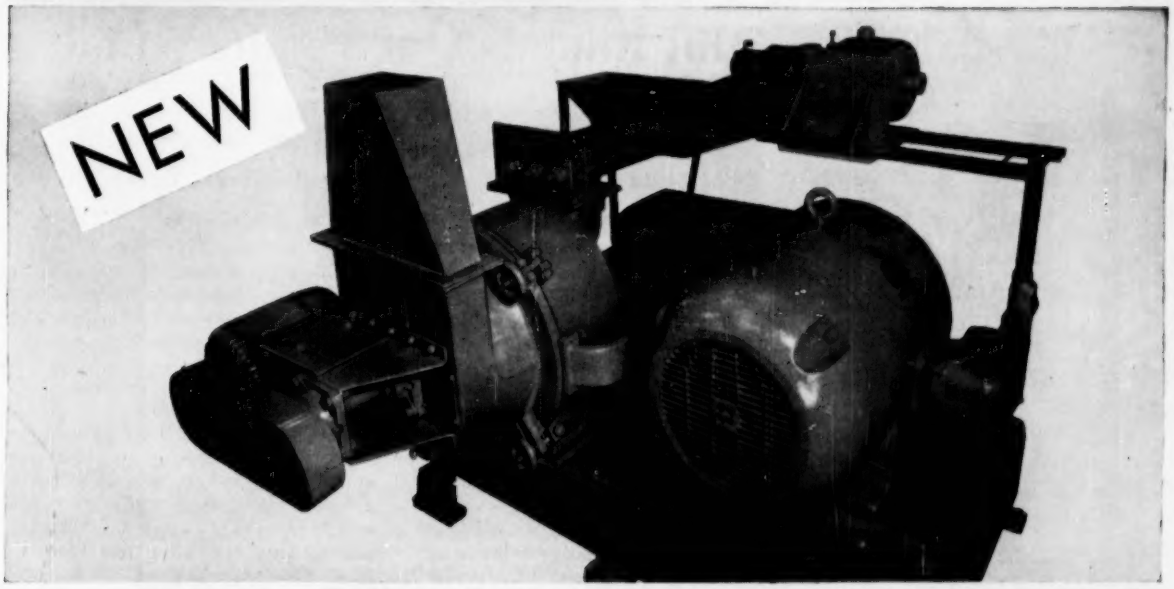


FOR PRECISION GRINDING AND CLASSIFYING IN ONE OPERATION

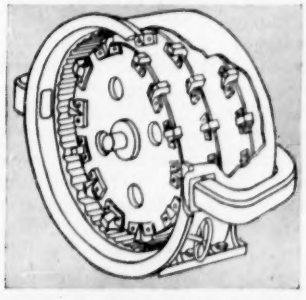
The PULVOCRON . . . An Air Attrition Impact Pulverizer and Classifier with Controlled Radial Inward Air Classification.

Now in one compact unit you can have a pulverizer and a classifier plus an automatic feeder, with separate controls over each. This assures positive particle size control and high capacity over a wide range of products. The Pulvocron will produce particle sizes from a range of 99% less than 5 microns or as coarse as 50 mesh, depending on the material and desired results.

The grinding chamber contains three adjustable plates with twelve staggered beaters on each. It also features added versatility through interchangeable liners of corrugated, perforated or smooth finish, plus variable rotor stator clearances.

The Classifier unit is on a hinged section with quick-open locks for simplicity of operating adjustment or cleaning.

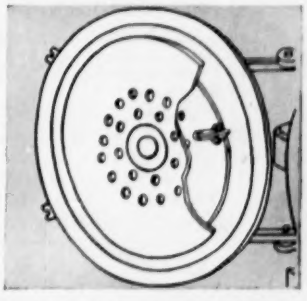
Material is both ground and classified through high centrifugal pressures set up by the beater and classifier plates. The Pulvocron is designed with oversize returns for automatic feed back of any oversize for further grinding.



Grinding chamber with adjustable plates, removable liners and oversize returns.

CONSULT STRONG-SCOTT

Strong-Scott offers you a modern up-to-date laboratory containing specialized testing equipment. This is backed by an expert engineering staff to furnish layout and design service at no additional cost to you.



Classifier Unit with separate motor. Swings open as a hinged section with quick open locks.

ON DISPLAY Booths 1138 1142 and 1144

at the **Chemical Industries Show** **Dec. 2-6, New York**

The **Strong Scott** Mfg. Co.

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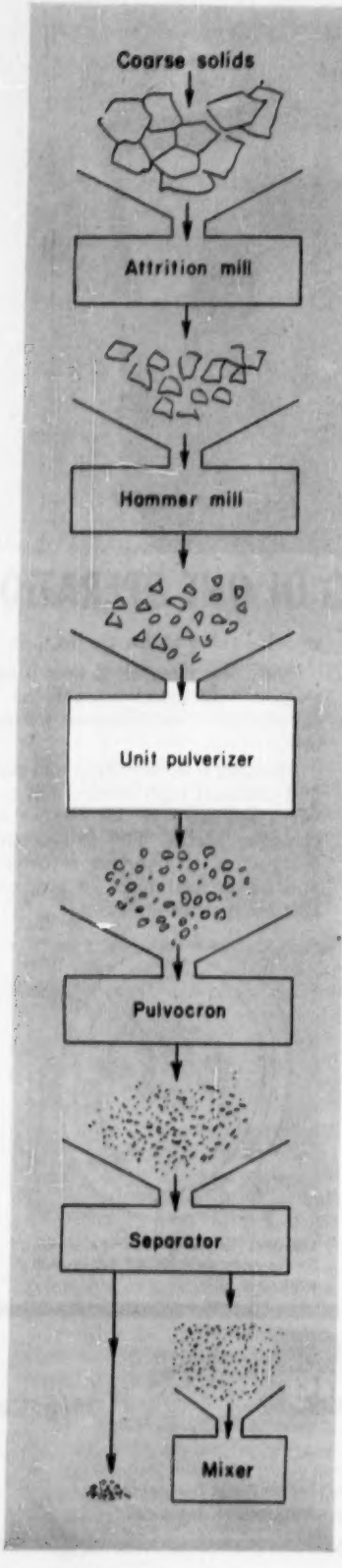
Equipment Designed for Better Processing

451 TAFT STREET, MINNEAPOLIS 13, MINNESOTA



Mill Rounds Out Vendor's Line

Revamped pulverizer-classifier completes new broad line of grinders, separators and mixers. Backed by production testing service, line blankets customer needs.

Strong-Scott's newly developed unit pulverizer rounds out its broad line of solids-processing equipment designed to handle materials ranging from fine micron sizes to coarse granules. Included in the lineup are solids-reduction mills, classifiers, separators and mixers.

The new unit pulverizer now being offered is descended from an earlier machine used successfully for pulverizing coal. Through a number of changes, the older design has been converted into a machine suitable for broad process application. It will be most useful for grinding non-metallics such as calcium carbonate and talc, as well as some plastics.

Solids are broken by impact with revolving hammers and with adjoining particles. Fragments from these impacts are swept by an air current into a classifying chamber. Vortex action in the chamber draws coarse particles down again to the mill; fines escape upward to discharge. Up to 99% of feed may be reduced to −200 mesh and up to 70% to −325 mesh.

Machine is built in four sizes from 10 to 42 in., 10-200 hp., 800–15,000 lb./hr.

▶ **Other Recent Additions**—Introduction of the unit pulverizer follows closely announcement of other machines in the Strong-Scott line. In March of this year, the Turbulizer continuous highspeed mixer was placed on the market (*Chem. Eng.*, July '57, *p.* 188).

January 1957 marked the initial appearance of the Pulvocron, an economical producer of −325 mesh particles (*Chem. Eng.*, Jan. '57, p. 152). Since that introduction, redesign of the classifier section has enabled the machine to produce fine product with a clean cutoff point at 40 microns.

According to Tom Haigh, Strong-Scott VP, this contrasts sharply with product from other air-attrition impact pulverizers which invariably contain some particles that definitely are oversize. Machine is available with 20- or 38-in. chamber, 25–150 hp.

▶ **Busy Last Year**—A year ago, Sept. '56, Strong-Scott brought out a triple-action mixer with special features for chemical and food use. Meeting sanitary codes, this machine provides close clearance between ribbon and tub. Special seals separate tub from shaft. Tub has drop bottom for easy discharge.

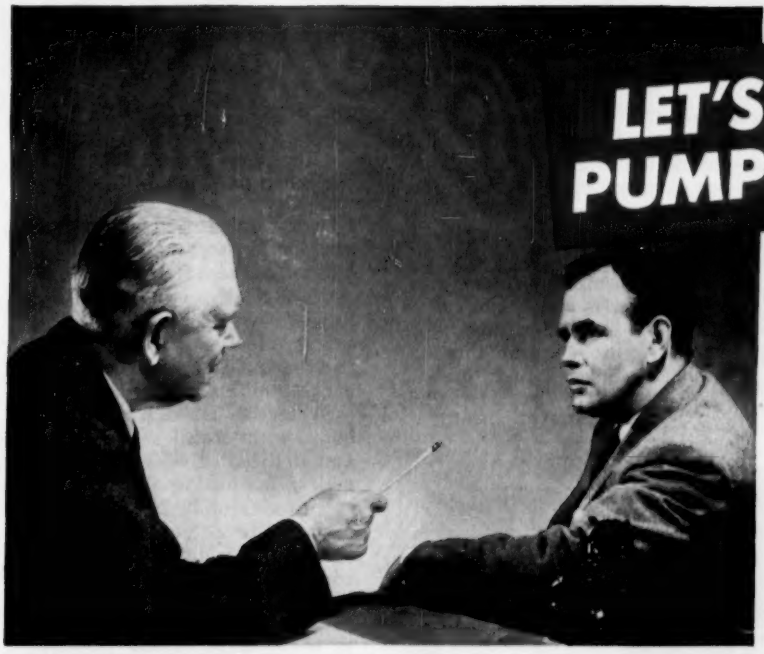
Then in June '56, company introduced a hammermill with specially hardened screens, that can be reversed four different ways, instead of the usual two. Replacement cost per screen was lowered. For grinding in the 20–150-mesh range, this machine is built in 12-, 14- and 24-in. sizes, 40–125 hp.

Also, the same month, a new attrition mill was offered for the first time. Features included runner heads mounted directly on the motor shaft.

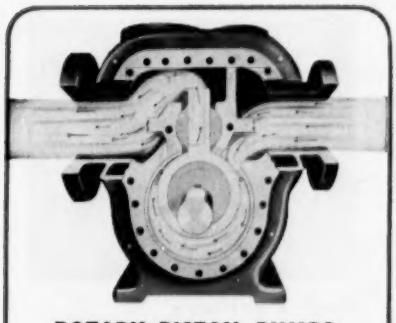
▶ **Other Units in Line**—Not mentioned among the newer additions and changes are several other hard-working items in the Strong-Scott line. A twin-rotor continuous mixer, rotating at 71–350 rpm., handles spray dried or flaky materials without breakage. Uni Blend machine adds as many as four liquids to solids with automatic thermostatic control at throughputs up to 15–30 tons/hr.

For screening, Powerflo separators come in 60-in. length and 24-, 36- and 48-in. width.

▶ **Proven by Test**—To demonstrate how it can marshall these various units to solve customer problems, Strong-Scott undertakes trial runs on submitted materials to obtain actual processing information. — **Strong-Scott Mfg. Co., Minneapolis 13, Minn.** **190A**

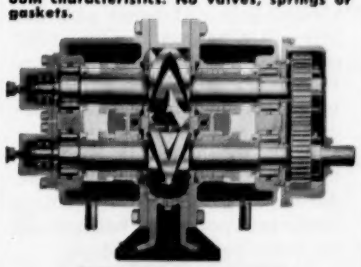


What Penalties Do You Suffer in Moving Semi-Solids and Viscous Materials?



ROTARY PISTON PUMPS

Rotary, positive displacement type with displacements ranging from 1½ to 3,000 gpm for working pressures of 70 to 250 psi. Plain and steam-jacketed models. Handles wide variety of substances and can be used for metered delivery. Extremely high vacuum characteristics. No valves, springs or gaskets.



HELIQUAD PUMPS

Deliver continuous non-pulsating flow of liquid—viscous or non-viscous—ranging from gasoline to blackstrap molasses. Plain and steam-jacketed models. Selection of Heliquad rotors provides pumping design best adapted to the substance to be handled. Capacities to 2500 gpm, working pressures to 350 psi.

If you buy pumps on the basis of capacity, horsepower input and the price tag—this message is for you 100%. Pumping costs for handling "hard-to-pump" substances cover a wide range of considerations if the true economy picture is to be exposed—first cost can be very misleading. For instance: time lost getting material up to a pumpable temperature can cost you more than the pump. Steam-jacketed KINNEY Pumps operate efficiently at substantially lower temperatures. Making plant changes, to accommodate a "price" pump with inadequate suction efficiency, can be costly. Where the pumping problem is not "run of the mine," the sound approach is to know all the facts about

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KINNEY Pumps afford you a virtual "prescription" selection to accommodate your pumping requirements. KINNEY Heliquad Pumps give greater suction lift than other pumps for two very sound reasons: 1. The chamber for entrance of material to the pumping area is large, open and unimpeded, 2. The rotor design develops larger openings to suck in and expel the fluid. And, KINNEY provides a selection of Heliquad rotors in configurations which adapt the design to the material pumped. KINNEY Pumps are the economical answer to hundreds of "sticky" production problems. They're not cheap . . . they just save money!

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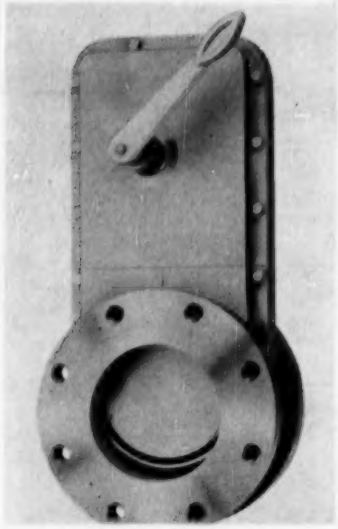

High Vacuum Valve

Compact 6-in. size offers system flexibility.

A unique new 6-in. high-vacuum valve offers the user choice of flange dimensions and minimum space between flange faces.

Four standard flange combinations are available from stock. Any special customer specifications, within limits of flange diameters, are available quickly on order.

Offering an original quick-acting slide action actuated by turning the handle through a semi circle, the VG-106T valve provides an unobstructed, straight-through opening. Valve is 100% leak tested and guaranteed leak tight.—**Vacuum Research Co., 420 Market St., San Francisco 11, Calif. 192A**

Pipe Lining

Can be used over wider range of temperatures.

Dow has developed a new saran lining for pipe, valves, pumps and fittings used to handle corrosive liquids and gases. Coefficient of thermal expansion of the new gray lining is 50% less than for its predecessor. Immunity to chemical and abrasive damage is the same as before.

Expansion and contraction of the new lining is approximately equal to its steel casing. From well below zero to 200 F., this lining material operates without damage. Field testing under extreme temperature variations indicates impact resistance is also better.

Standard stock sizes of pipe, valves, pumps and fittings with the new lining are available from inventory at no increase in price.—**Saran Lined Pipe Co., Ferndale, Mich. 192B**

Plastic Valve

Combines best features of gate and glove valves.

In the new Flex-Plug plastic gate valve, users get both flow-control throttling and straight-through flow without pressure drop.

Offered in both rigid PVC and Uscolite copolymer material, valve has a conical plug covered with an easily removable synthetic cap that seats against the inside of the body. The developed curved design of the flexible cap and plug allows you to throttle flow with minimum turbulence.

Swivel mounting of cap permits it to turn so that it seats in a different position each time. It can be removed and replaced with ease without taking the valve out of the line. When open, hydraulic pressure seats the flexible cap against the bottom of the bonnet, relieving pressure on the packing.

Valve is rated for 200 psi. working pressure, is available in 1 and 2-in. sizes with screwed ends. Other sizes from ¼ through 4 in. will be announced at a later date.—**Vanton Pump & Equipment Corp., 201 Sweetland Ave., Hillside, N. J. 192C**

Line Protector

Prevents freezeup of lines when pressure fails.

In the case of pressure failure, the Velan freeze protector drains condensate lines automatically at a predetermined temperature of 90 to 120 F. It saves condensate lines, exposed to freezing temperatures, from breaks and lost production time.

Protector has a forged steel body with stainless-steel trim and stellited valve seat. It is installed in the low points of return mains or before risers.

Valve is actuated by a bimetallic element. Normally, condensate is sufficiently hot to keep valve closed. Should condensate cool because of failure in boiler pressure or stoppage in line, bimetallic element opens the valve to drain the line quickly.—**Velan Steam Specialties, Inc., 37 South River St., Plattsburg, N. Y. 192D**

Gas Purifiers

Now built for service up to 15,000 psi.

Purifiers now are designed for 15,000 psi. service on air, steam, process vapor and gas lines. Units operate by using carefully controlled centrifugal force to guide entrainment-laden vapor through a series of vanes and baffles.

In the first stage, larger droplets impinge against a baffle. Second-stage separation element removes fine mist entrainment by centrifugal scrubbing.

Purifier shown above works on compressor discharge in a synthesis gas processing plant. Handling a flow of 104,400 lb./hr. of gas, it removes 10 lb./hr. of water and 4 lb./hr. of oil at an operating pressure of 6,905

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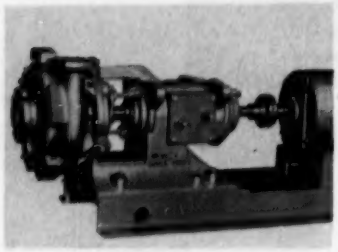
psi. at 110 F.—**V. D. Anderson Co., Div. of International Basic Economy Corp., 1935 West 96th St., Cleveland 2, Ohio. 192E**



Centrifugal Pump

Designed to include many operational features.

New "H" series single-stage, end-suction centrifugal pump offers choice of three types of wet-ends to meet specific operating needs.

Type HR pump handles abrasive mixtures where head is limited; Type HC with split bearing stand is for purely corrosive applications; Type HF works on either abrasive or corrosive applications where high pressures are developed.

Casing can be rotated to any one of four positions. Adjustment of seal takes only moments with a wrench, can be done while pump operates. Packing gland also is readily accessible and easy to adjust.

Series H pumps come in sizes from 1 to 10 in. for heads up to 250 ft. or more and capacities to 4,000 gpm.—**Nagle Pumps, Inc., 1249 Center Ave., Chicago Hgts., Ill. 194A**

Steel Pipe

Two-ply coating prevents external corrosion.

Desirable properties of steel pipe and polyethylene are combined in the new X-Tru-Coat pipe. Designed for underground service in the gas, oil and chemical industries, it withstands corrosive soils, water, fumes and electrochemical action. Yet, it possesses strength and safety factors normally associated with steel pipe.

Selected butt-weld or electric-weld pipe is coated hot with a special elastic adhesive. Then, over this undercoating is extruded a controlled thickness of polyethylene plastic. Coating is cut back from the ends for welding or for threading.

Undercoating remains elastic and live at all times so that pipe can be flexed or bent without destroying the bond. Further, undercoating seals accidental cuts or abrasions, prevents under-film migration of moisture at the ends of plastic coating or in damaged areas.

Tough polyethylene outer coating matches the flexibility of the undercoating. Field joints are made with regular pressure-sensitive tape and primers.—**Republic Steel Co., Pipe Div., Cleveland, Ohio. 194B**

Chemical Feeder

Fits into drum, operates on vacuum.

With the Add-A-Kem drum-top feeder, it is claimed that you can feed chemicals directly from a drum to point of use. You merely need a vacuum outlet to furnish the motive power.

Unit incorporates a precision metering valve to control flow from drop rate up to 1 gpm. Sightglass aids in setting the rate. When drum becomes empty, shutoff valve closes at end of feeding riser in bottom of drum. At same time, gage on top of drum signals that drum is empty.

Add-A-Kem feeder can be changed from one drum to another within one minute without tools and without interrupting flow rate.—**Sterling E. Norcross, 19 Osborne St., Bloomfield, N. J. 194C**

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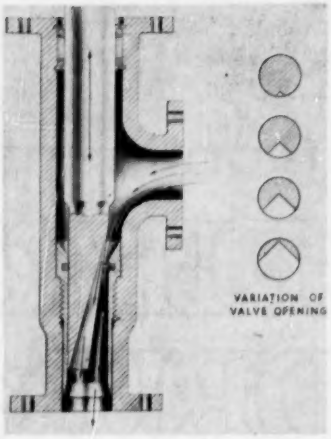


Tapered Orifice Valve

Controls like needle valve, is virtually clog-proof.

For nearly all applications, the tapered orifice valve is reported able to replace the needle valve. By concentrating all of the flow area in one triangular section rather than around an annular ring, it becomes virtually clog-proof. In the nearly closed position, it will pass foreign particles 20 times larger than will a needle valve.

Flow of fluid or gas is controlled by moving a plug with a tapered slot in and out of a circular opening. This, in turn, varies the cross-sectional area of the slot at the head of the opening. A circular sealing ring prevents bypassing.—**General-American Valve Co., P. O. Box 444, Corano Del Mar, Calif. 194D**

Diaphragm Valve

Ductile iron construction withstands shocks.

A new ductile-iron diaphragm valve is claimed to meet industry-wide need for exceptional strength and resistance to fracture and thermal shock. It has the tensile strength of cast steel valves, yet is economical.

These valves are available as complete valves or as replacement components of bodies, bonnets and handwheels. Sizes range for screwed ends from ¼ to 3 in. and for flanged ends from ¼ to 8 in.—**Hills-McCanna Co., 2341 West Nelson St., Chicago 18, Ill. 194E**

...more

POWELL VALVES

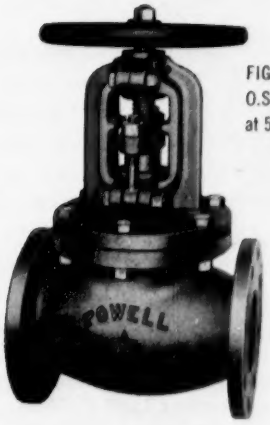
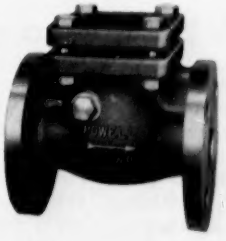


FIG. 2429—Large Size Stainless Steel O.S.&Y. Globe Valve for 150 Pounds W.P. at 500 F. or 230 W.P. at 100 F.

FIG. 1314A—1500-Pound Integral Bonnet Stainless Steel "Y" Valve.

FIG. 2453SG—Stainless Steel O.S.&Y. Gate Valve for 150 Pounds W.P.

FIG. 2342—Stainless Steel Bolted Cap Swing Check Valve for 150 Pounds W.P.



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Consult your Powell Valve distributor for all the facts about quality proved bronze, iron, steel and corrosion-resistant valves. For every flow problem . . . there is a Powell Valve to solve it.

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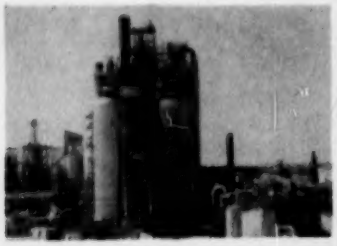
Camera Captures Invisible Thermal Levels

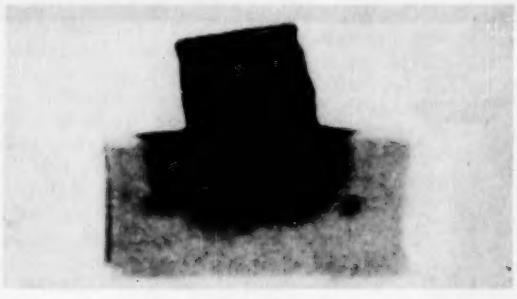
Reveals hot spots in operating refinery catalytic cracker



How refinery looks to the eye contrasts sharply with how it looks to a Barnes far infrared camera. Camera captures infrared emitted by equipment, measures temperature.

Discloses temperature gradient between dry and water ice

Dry ice rests on block of water ice and . . .



Cools adjacent water ice below its usual level.

DID you ever dream of taking temperatures with a camera? As you can see above, it is one dream that can come true.

For the first time, you actually can photograph the thermal condition of objects within normal temperature ranges. And from these pictures you can obtain accurate temperature readings.

▶ **New Dimension**—Using conventional or Polaroid Land film, the Barnes far infrared camera can "shoot" a thermal picture of any object, no matter how cold. Black and white shadings in the picture are produced by gradations in the amount of infrared energy emitted by the object, rather than by the amount of visual light it reflects. Each point on the photographic image can be converted into a temperature reading.

This type of photograph enables us to visualize temperature differences around us. Or, as explained by Dr. R. Bowling Barnes, it . . . "adds a new dimension to our senses, just as conventional photography did when it was first introduced."

Greatest advantage of the Barnes camera is that it pictures, for us, thermal conditions below red heat, or 1,000 F. Most industrial equipment operates below this limit. Now, through the eye of the Barnes camera, engineers can learn many new things about thermal conditions.

In the chemical, petroleum and processing fields, transfer and containment of heat are basic to the operations. How it takes place, what's wrong with it, and how it can be improved may be learned with the Barnes camera. Similarly,

Where can you use the unique characteristics of persulfates?

All peroxygens carry active oxygen in their molecules, but the persulfates offer these special properties as well: Unusually high oxidation potential, good resistance to catalytic decomposition, and a reactive anion that gives reactions quite different from those of other peroxide compounds.

You'll find persulfates have particular values in processes involving emulsion polymerization of monomers and depolymerization of organic polymers. Persulfates excel in such applications as processing color films, etching printing plates, and modifying starches; and are of interest as reactive oxidizing agents for many other purposes.

Perhaps *your* processing techniques can be improved through the use of Becco Persulfates. A Becco field engineer will be glad to discuss this with you, at no obligation . . . drop us a line. At the same time, ask for your free copy of these booklets:

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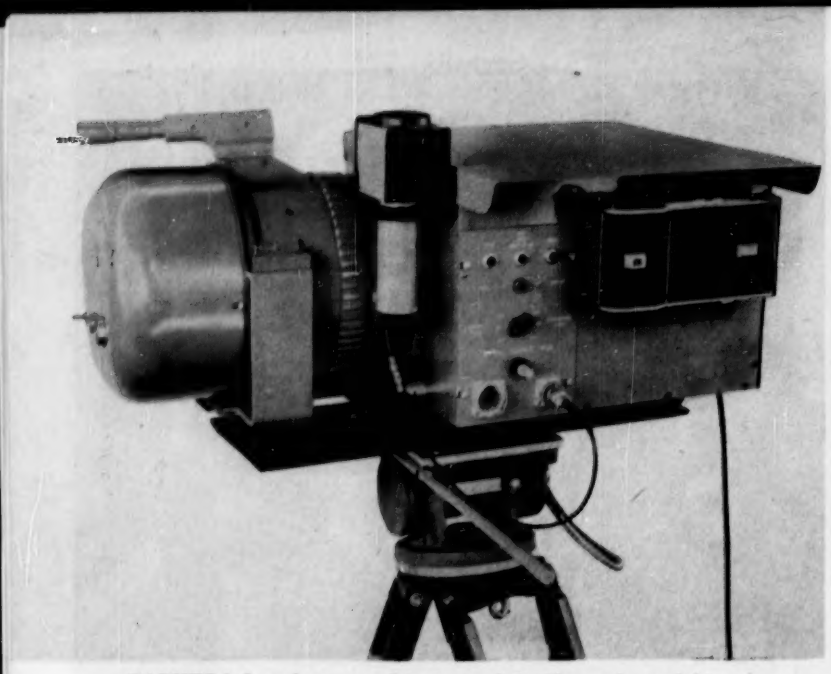

BARNES infrared camera, detector on left, film pack on right.

faulty or overloaded equipment can be detected.

▶ **Links Infrared to Visual**—In essence, the Barnes camera scans an object in horizontal increments to pick up varying amounts of infrared energy radiating from it. Infrared detector in camera produces an electrical signal proportional to the amount of infrared energy received.

After amplification, this signal modulates the output from a visual-light glow tube. A recorder mirror mounted integrally with the scanning arrangement casts this varying light beam on the photosensitive film duplicating the scanning pattern on the object being photographed. Result is a photo image of a thermal condition.

▶ **Narrow or Broad**—The detector or radiometer electronic system can be adjusted to cover a narrow or wide temperature range. Also, an electronic temperature offset permits the operator to shift the range up and down the temperature scale. This can be augmented by a temperature controller connected to the black body in the radiometer head.

Sensitivity is high, depends on the time taken to scan the object. Camera detects differences as small as 0.04 F. with a 15-min. scan, up to 0.4 F. with a 2-min. scan.

▶ **Comparative Standard**—Total infrared emitted from various parts of the target area can be determined quantitatively by measuring the density of various parts of the print. However, by a system built into the camera, a series of eight density steps ranging from black to white are produced along the edge of each picture.

This gray scale calibrates the print in terms of the radiometer signal. Thus, thermal analysis of the print is independent of the glow tube and the film-developing process.

Each step in the gray scale represents a precisely known radiation temperature level. By visually comparing various sections of the print with the gray scale, the picture can be analyzed quite accurately. Since the radiometer system can be adjusted to make small temperature differences produce different tones of gray in the picture, temperature can be measured accurately without resorting to densitometer readings.

▶ **Recently Declassified**—Camera is an adaptation of a basic design for military use which was declassified only recently. For that reason, application to industrial problems is just starting.

Initially, cost probably will be in the $15,000–25,000 range. Although present model works on a.c. power, units can be built portable for operation on battery power.—**Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.** 196A

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HOT pipe, cold hair and ears.

Particle Sizer

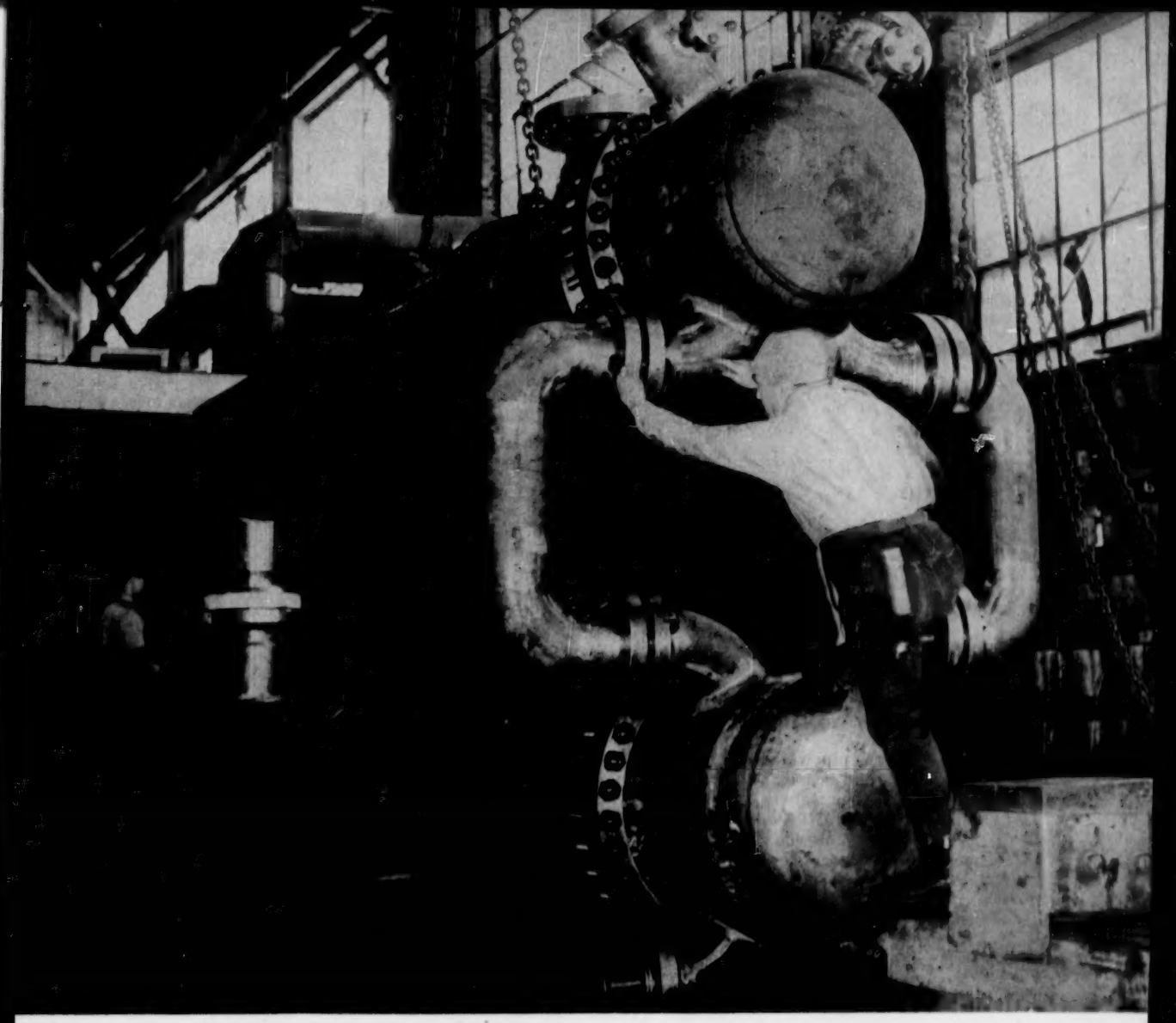
New way to count fine particles and determine sizes.

Out of the medical-biological field comes a new way to count fine particles and determine distribution of sizes in the 0.7-200 micron range.

A single count on a 0.5 c.c. sample takes 10-15 sec. A 10-point particle content and size distribution determination requires 5-10 min. On counts, over-all accuracy is 0.5% or better.

The Coulter counter forces a fluid suspension of particles through a small aperture having an electrode on each side. As a particle passes through the aperture, it changes the electrical resistance of the aperture in proportion to the particle size. The resultant series of electrical pulses is electronically scaled and counted.

Virtually any type of particle may be measured. Fluid medium must conduct electricity and the conductivity ratio between liquid and solid should be 3:2 or greater. A range of particle



"Special" in Every Way

Made entirely from Type 321 stainless steel, this unusual heat exchanger demonstrates The M. W. Kellogg Company's ability to engineer and fabricate such equipment to special as well as standard specifications. In this case, special welding procedures were developed, as well as special methods of seal-welding tubes to tube sheets; special machining of the tube sheet was required for each tube; and special techniques were employed for testing. Special in every way, this unit is scheduled for special service in an English oil refinery.

FABRICATED PRODUCTS DIVISION

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sizes up to 20 to 1 can be handled with a single aperture. —**Coulter Electronics, 5227 North Kenmore, Chicago 40, Ill. 198A**

Pipewall Gage

Nondestructive type measures pipewall thickness.

You can measure pipewall thickness quickly and easily with the new AccuRay portable pipewall-thickness gage. Utilizing the principle of radiation absorption, gage measures absolute pipewall thickness directly.

All you need to do is to place the detector in position on the pipe, press the measuring button and take the reading from the meter. An integrating circuit eliminates need for you to mentally average and interpret fluctuating indications.

Reading is independent of diameter. Reproducibility and resolution are better than 0.010 in. throughout a range of wall thickness up to 1 in. Instrument weighs only 7½ lb.—**Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio. 200A**

Valve Operators

Electro-hydraulic type, need no electronics.

Producing high performance without use of electronic amplification, a new line of electro-hydraulic valve operators utilizes only simple, direct-current force motors to operate the hydraulic pilot. Nozzle-flapper combinations in the pilot control hydraulic pressure, eliminating sliding plate or spool type valves which stick easily.

Type 340 operators mount on valve sizes from ½ to 4 in.; develop stem thrusts up to 600 lb. Type 350 mount on valve sizes from ½ to 16 in.; develop stem thrusts up to 2,000 lb. Both operators may be adapted to operate on the d.c. input signal from any instrument now available. — **Fisher Governor Co., Marshalltown, Iowa. 200B**

Automatic Analyzer

Analyzes plant stream titrimetrically without operator control.

Simulating a skilled chemist, the Titromatic analyzer draws plant stream samples, analyzes them and records the results. It operates day and night without attention, other than a routine weekly inspection.

Analyzer can handle either acid-base or reduction-oxidation titrations to any endpoint between pH 2 and 12. Sample is drawn into flask, agitated, diluted and titrated with standard reagent to a pH endpoint.

Amount of reagent used is determined by an electric eye and recorded on a chart. In the meantime, flask empties and refills for another determination.

Time cycle can be varied between 3 and 30 min.—**Robert-Shaw-Fulton Controls Co., Instrument Div., 2920 North 4th St., Philadelphia 33, Pa. 200C**

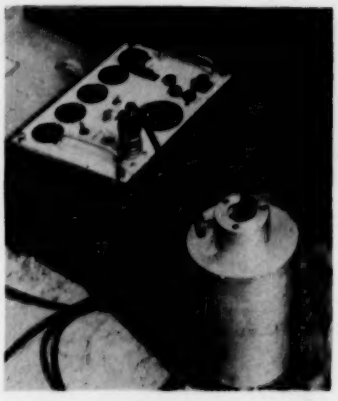
Stream Selector

Controls monitoring by stream analyzers.

An automatic stream selector now is available for use with Beckman's industrial gas chromatographs, hygrometers, infrared and other type stream analyzers.

When used with chromatographs, stream selector makes possible the consecutive monitoring of two or more identical streams. A series of numbered lamps indicate which streams are included in the chromatographic system, which streams are being monitored, and the particular system being analyzed at the moment.

Selector may be set for automatic or manual operation by use of a manual advance button located on the panel. It operates through control of solenoid valves on a manifold.—**Beckman Instruments, Inc., Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif. 200D**



Moisture-Density Gage

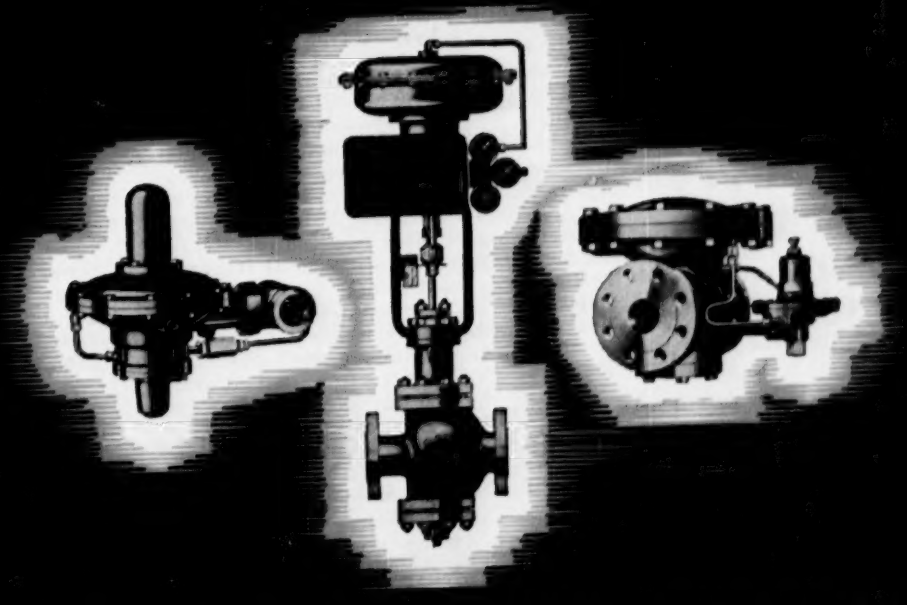
Portable instrument relies on radioactive scattering.

Moisture content or density can be measured in a wide range of organic and inorganic materials with the new portable d/M gage. A single operator can complete an accurate determination within 2 min., one tenth the time needed with other methods.

Gage operates by measuring the degree that a mass of material scatters the rays from a radioactive source. Moisture probe contains radioactive radium-beryllium as a source of fast neutrons; density probe contains a cesium-137 gamma ray source. Probes are used interchangeably with a radioactivity counting instrument (scaler).

Probes normally measure a spherical volume of material averaging 14 in. in dia. Accuracy of density determinations is within 2 lb./cu. ft. over the 50-150-lb. range. Moisture determinations are accurate within ¾ lb./cu. ft. from 0-100% water.—**Nuclear-Chicago Corp., 229 West Erie St., Chicago 10, Ill. 200E**

the tough Control Valve jobs go to



FISHER GOVERNOR COMPANY
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Shaft-Mounted Drive

Larger capacity, single and double reduction.

A completely new, larger capacity shaft-mounted drive is reported now in production. Longer center distance between shafts permits use of larger sheaves on installations where unit is mounted with input shaft toward driven machine or on through-shaft applications.

All-steel 315J shaft-mounted drive is built in single reduction ratio of 5:1 and in two double reduction ratios of 14:1 or 25:1. Unit ratings range from 2 hp. at 5 rpm. to 50 hp. at 359 rpm.; maximum torque rating at low shaft speed is 31,000 lb.-in.

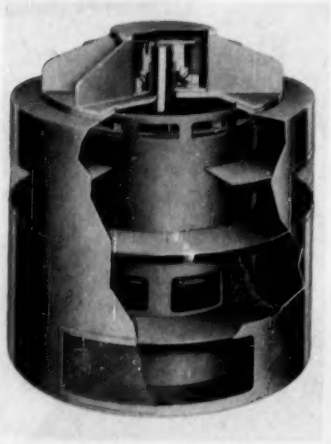
Drive has inspection covers for easy inspection of bearings and helical gears. Oil level can be checked with a dip stick.—**Falk Corp., 3001 West Canal St., Milwaukee 1, Wis.** 202A

Ground Detector

Eliminates grounding hazard on 3-phase systems.

Fluctuation of voltage in any phase on a 3-phase electrical system is never immediately evident, but it does change voltages and ground potentials on the other two phases. And it does create serious hazard to men and equipment. Even small amounts of excess grounding will shorten motor life and raise power bills.

Voltage changes as small as 1 v. are detected by the PRD-C5700 ground detector which then gives either visual or audible alarms. Installed at any control point, device protects all equipment on one system. Operating at 110 v., detector has transformer to permit connection to power line.—**Principle Research & Development Co., Box 93, Franklin Park, Ill.** 202B



Weather-Proof Motor

Vertical type now available in NEMA II enclosure.

For application outdoors on pumps and other vertical drives, squirrel-cage motors and wound rotor induction and synchronous types from 250 hp. and up are now built with weather-protecting enclosures according to NEMA Type II standard.

Baffles force incoming air to change direction abruptly 90 deg. or more before reaching the electrical parts of motor. To further assure that moisture or dirt particles will drop out before reaching internal parts, air velocity remains below 600 ft./min.

Additional protection from the weather comes from Silco-Flex silicone-rubber stator coil insulation. Virtually waterproof, it resists acids and alkalis, is resilient against abrasives.—**Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.** 202C

Gas Turbine

Smaller unit joins existing line of turbine drives.

To drive pumps, compressors or generators, Westinghouse has added a new 3,250-hp. gas turbine to its line of gas turbines rated 5,000, 8,000 and 12,000 hp.

Operating at 8,500 rpm., turbine can provide any drive speed through gearing. Top operating speed is reached within 3 min.

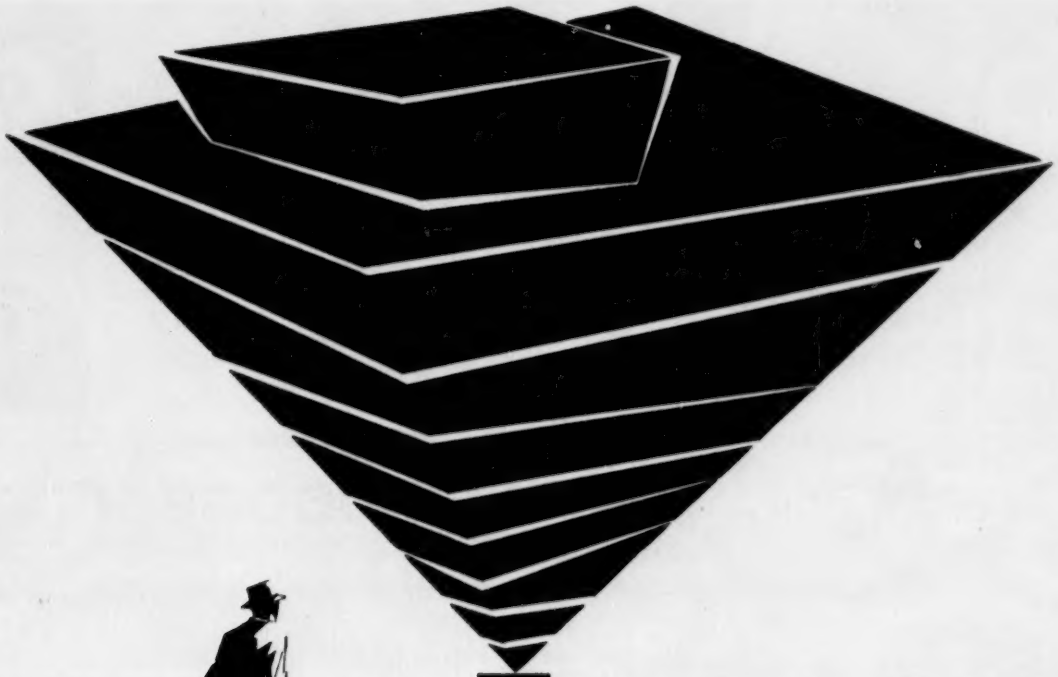
At full load, 775-deg. exhaust gas flows at approximately 191,000 lb./hr. At this temperature, gas can produce low-pressure steam through interchange with a waste heat boiler or heat exchanger located in the exhaust duct.

Turbine, starter auxiliaries and controls, and driven machine are all mounted on a common bedplate. Only external utilities need be connected to put plant into operation.—**Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.** 202D

New gearmotors, vertical Type MV, drive vertical shafts such as mixer shafts. Also good for wall-mounted jobs. Available for 1-15 hp. std. NEMA D-flange motors.—**Cone Drive Gears, Div. Michigan Tool Co., 7171 East McNichols Rd., Detroit 12, Mich.** 202E

For dry bearing service up to 500 F., Chemloy bearing material is reported able to withstand solvents and practically all types of corrosives.—**Crane Packing Co., 6400 Oakton St., Morton Grove, Ill.** 202F

Three-part fitting attaches load to a continuous cable. Used for rigging, pulling cars and barges, etc. Consists of wedge clamp, wedge and cable clip.—**Sauerman Bros., Inc., 642 South 28th Ave., Bellwood, Ill.** 202G



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Already in its sixth major expansion in five operating years, Chemstrand's greatest growth still lies ahead! Our company's field of chemical-textile fibers is young . . . but growing rapidly. Our industry calls for an 8-fold increase by 1975!

At Chemstrand, right now, there are a number of creative engineering projects just waiting for capable men to put them into action. The men who join us today will be the experienced, sought-after "pioneers" of tomorrow.

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TECHNICAL PERSONNEL MANAGER, Dept. (ChE-12-57)
The Chemstrand Corporation, Decatur, Alabama

Gentlemen:
It is my understanding that you need for immediate employment graduate engineers in various fields, particularly chemical, mechanical, industrial, textile and instrument engineering.
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Please send me information concerning the ground floor opportunities at Chemstrand.

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STREET _____
CITY _____ ZONE ____ STATE _____

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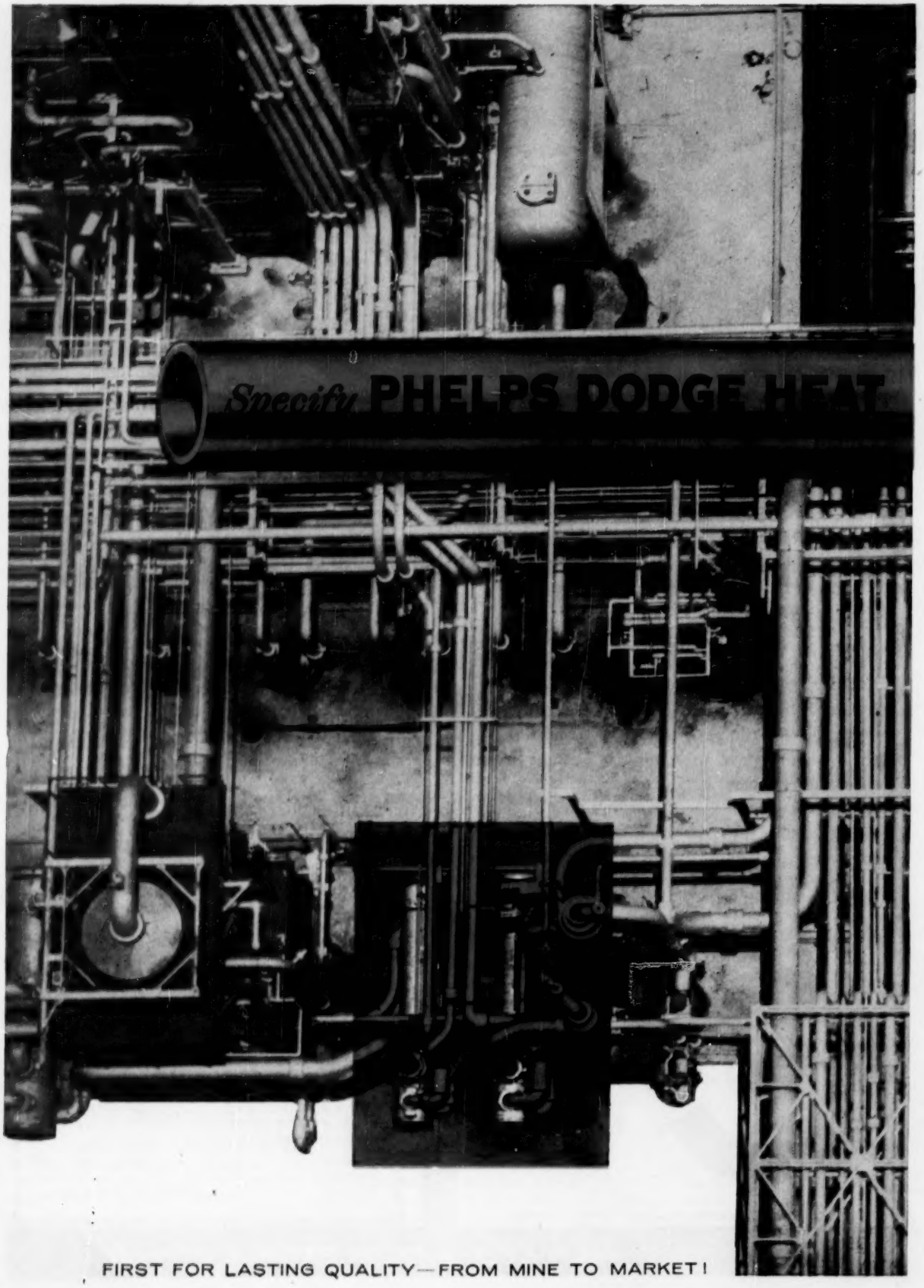

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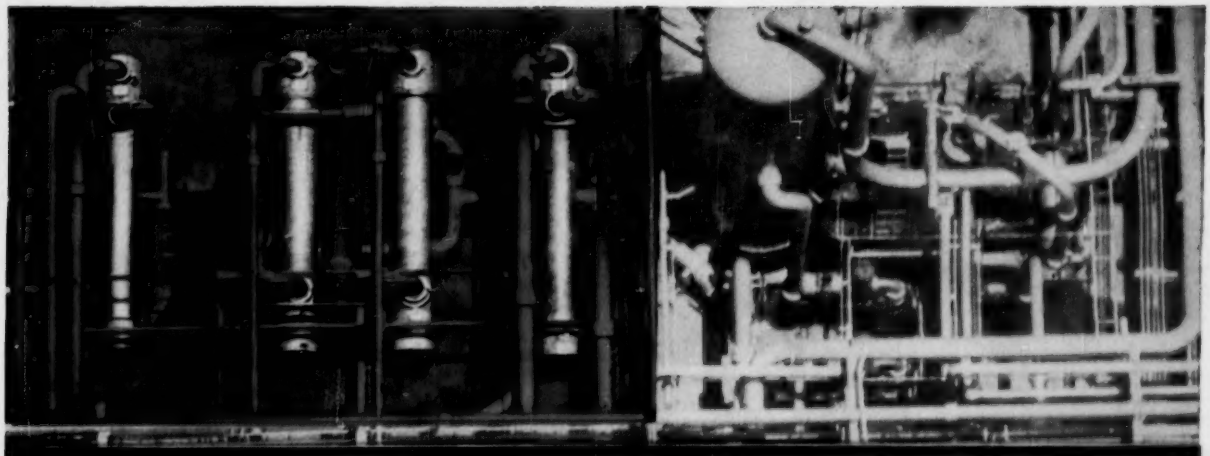

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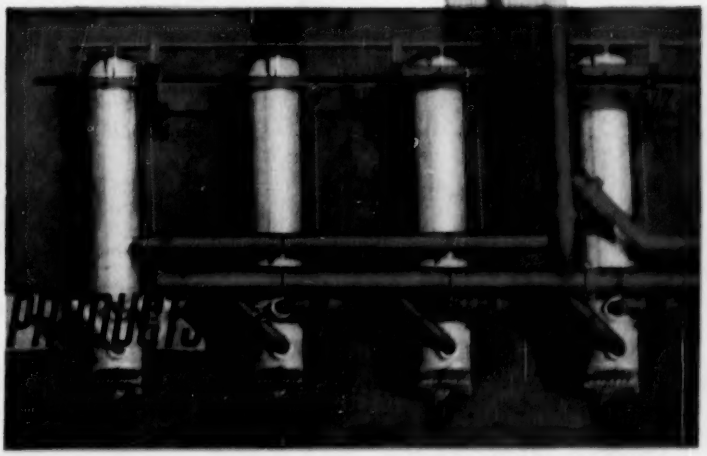

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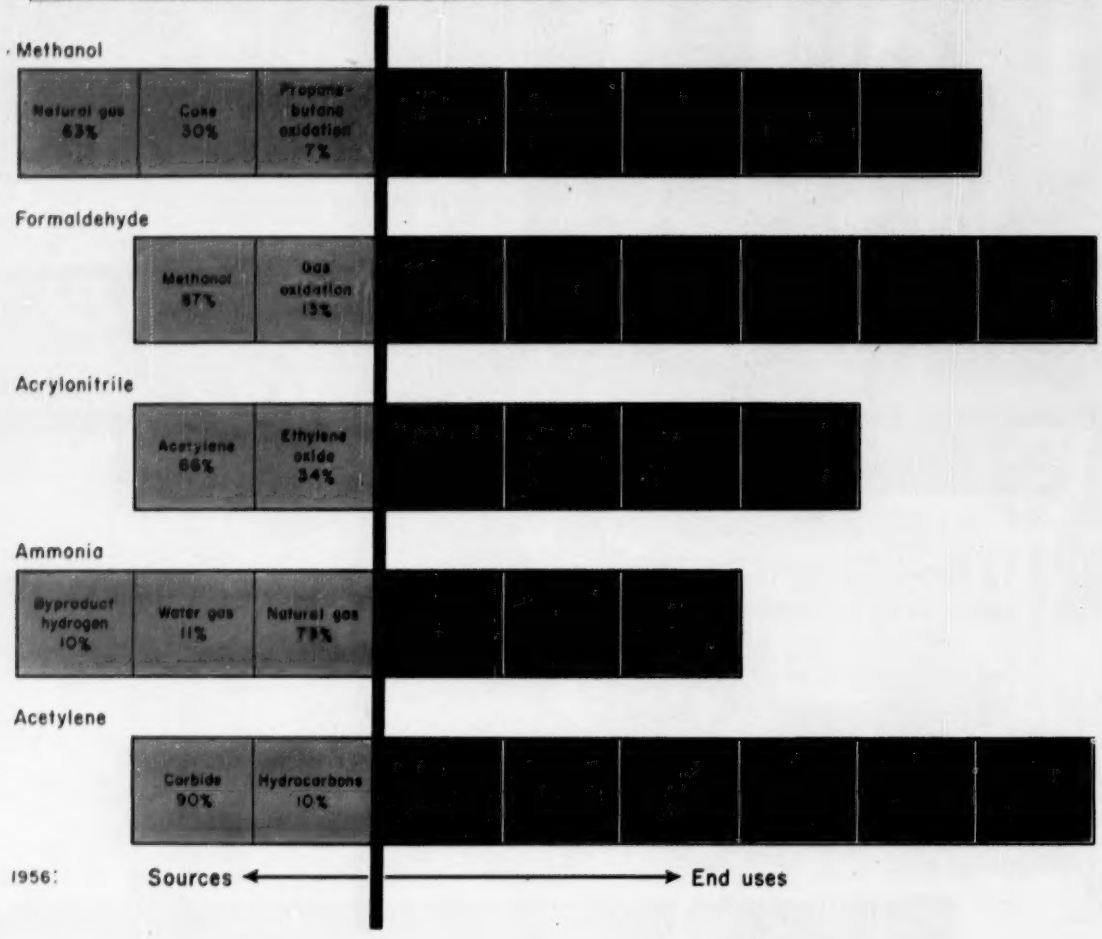
DEVELOPMENTS ...

CHEMICAL ECONOMICS

EDITED BY D. R. CANNON



Peppy Petrochemicals Line Up to Be Counted

Three wide-angle views of the petrochemical industry: This month, methane derivatives; coming soon, chemicals from ethane and higher hydrocarbons.

James W. Bradley, Robert L. James and Richard F. Messing, Arthur D. Little, Inc.*

PETROCHEMICALS have developed to the point where they are no longer a stepchild in the chemical family. Although some still regard them only as by-products of an operation intended to satisfy fuel needs of the country, petrochemicals have gradually assumed a significant role in their own right. Even though raw material consumption is still less than 1% of total hydrocarbons available, petrochemicals now represent 25% of total chemical industry production.

The problem of definitions is troublesome. For this purpose, we'll consider petrochemicals as chemical products derived from petroleum and natural gas. A convenient method of sub-dividing petrochemical materials is on the basis of the raw materials from which they are derived. This series of articles covers derivatives of methane in the first issue, C_2 hydrocarbons in the second, and higher hydrocarbons in the third.

▶Big by Any Measure—Although opinions vary on the

*Meet your authors on pages 336-337.

trimethylolpropane

produced in continuous volume . . . at low cost!

Trimethylolpropane . . . produced by Celanese' unique aldol condensation process . . . is now ready for commercial application at new low price. Specially developed processes which utilize Celanese-produced basic materials assure continuous large volume production, exceptional high purity.

Manufacturers of paints and protective coatings can now take full advantage of the better adhesion, color, color retention, hardness and chemical resistance offered by trimethylolpropane alkyds.

Processing of polyurethanes is made easier through the use of this free-flowing, flaked polyol. Formulations containing trimethylolpropane mix more readily with diisocyanates. Its low melting characteristics and low water content are added features of particular importance in polyurethane coating formulations.

Rigid foams produced with polyesters containing trimethylolpropane have higher heat distortion points and are less susceptible to shrinkage. Flexible foams based either on polyethers or polyesters are made tougher through the use of trimethylolpropane.

The properties of this new polyol open the door to the commercial development of other important production applications —synthetic lubricants, plasticizers, surface active agents, polyesters. How will trimethylolpropane fit in your formulations? Write for working samples, prices!

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Hydroxy value, % by wt., min. 37.5
Water content, % by wt., max. 0.05
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Phthalic color, Gardner, max. 1
Acidity, as formic, % by wt., max. 0.002

A New Petrochemical Series from Old Hands

When we've got a good thing we like to stick with it. That's why we're especially pleased to bring you another petrochemical survey from Arthur D. Little, the same authority which created for us the still-popular series of two years ago (*Chem. Eng.*, Sept., Oct., Nov. 1955).

Of the original author triumvirate, two-thirds—chemical engineers Dick Messing and Bob James—is the same, joined this time by market researcher Jim Bradley. Together these men will bring you smartly up to date—and help you look ahead—in the ebullient petrochemical industry.

This month they first paint an overall industry picture, then take on methane derivatives. Look for ethane chemicals next month, higher hydrocarbons in February.

proper index to measure petrochemical growth, there is little doubt that the industry as a whole is growing more rapidly than the composite chemical field. When measured on the basis of dollar sales, the chemical industry has grown 14% during the last two years. The petrochemical industry has increased 21%.

Value of petrochemicals output is about $4.5 billion, and the general consensus is that the petrochemicals field, which now accounts for 25% of total chemicals, will grow to 40% by 1965.

▶ **Petrochemical Insight** — A number of characteristics are more readily associated with petrochemicals than with other types of chemicals. Some of the most interesting:

• Petrochemicals involve a high unit plant cost, usually of the order of $5-10 million, and reaching as high as $40-50 million for single facilities. This means that participants are usually well-established companies having the financial resources necessary to support construction and growth in this area.

• Processing methods are relatively standardized since it is possible to obtain standardized designs for many of the basic petrochemical products. Although individual variations or new techniques may give a few producers some advantage, there is relatively little difference, at comparable plant size, in manufacturing economics among the various producers of a given material.

• Sales outlets usually depend upon long-term relationships between producer and consumer. Pipeline delivery or some other close association is frequently involved between the supplier and the individual consumer.

• Development of new derivatives continues to be an important factor in the petrochemical field, although perhaps more in the area of secondary derivatives than in primary chemicals.

▶ **Oil Firms Want In, Too**—Although chemical companies dominate the petrochemical field, there's growing competition from companies whose operations are primarily in the petroleum field. And their percentage of petrochemical activity is increasing.

For it is no longer true that the petroleum industry generally views the chemical industry from the oil producers' view point, although admittedly some companies still fall in this category. More and more oil companies now want to diversify their operations and, particularly, to upgrade raw materials to chemicals to achieve a higher unit sales value.

Although chemical development and marketing problems have been, until recently, somewhat outside the scope of their activity many oil companies appreciate these factors and have added staffs competent to cope with the complex problems of petrochemicals.

▶ **Entrance Fee**—Most oil companies entering the petrochemicals field have focused efforts upon primary derivatives—on products like ethylene, butadiene, or aromatics. In many cases, however, these operations are regarded only as the first stage of a broader development. In fact, many companies will sacrifice return on investment in order to gain the foothold represented by such primary product manufacture. These companies expect that upgraded products, possible from development work or from new associations with chemical producers, will permit higher profitability. Basic facilities, therefore, become an "entrance fee" into the chemical field.

Essentially all major petrochemical derivatives are now overproduced in the sense that more capacity is available than can be sustained by present demand. This factor has significantly affected return on investment, particularly since the break-even point for many of the facilities is a high percentage of the rated capacity.

▶ **Growth Begets Growth**—Petrochemicals are the base for many of the most active growth materials in the chemical industry. Probably the largest single market is the synthetic rubber field, where the cost of hydrocarbons produced by the petrochemicals industry is a large portion of the total product cost. Other industries—such as plastics and synthetic fibers—are among the best performers and would support further vigorous growth in the petrochemical field.

Considerable research effort is being devoted to new methods of manufacture which will reduce petrochemical costs. New methods of oxidation, cracking, and cyclization may make it possible to more economically produce dibasic acids, methacrylate plastics, acetylene derivatives, isoprene and similar materials.

▶ **Methane Chemicals** — Most methane derivates are produced by processes that first convert this simplest hydrocarbon to carbon monoxide and hydrogen. Most important conversion process is reforming, but the newer, direct-oxidation process appears to be gaining favor.

Ammonia is by far the largest-volume petrochemical—one of the few hydrocarbon-based chemicals measured in tons instead

NEW CHIKSAN DISCPAK SWIVEL JOINTS

FOR STEAM AND HOT GAS SERVICE

Created specifically for service on lines employed in steam and hot gas service, the Chiksan Discpak embodies a new construction design which permits packing units to be replaced without removing the joint from the line. The outer housing of the Discpak is cut apart at the packing chamber and both ends are flanged at the cut. Four allen-type cap screw bolts are used to secure the flanges. A disc-seal, housed between the two members, provides a fluid-tight seal between rotating and stationary members of the Discpak Swivel Joint. A spring loaded pressure plate holds the packing in sealing position against the swiveling member.

The new Discpak has a maximum temperature rating of 600° F. and a maximum pressure rating of 300 psi. All turning movement in the Discpak takes place on a double row of precision ball bearings. Write today for literature and prices. If your plant or equipment lines utilize hot gas or steam, it will pay you to know about this new field-proven Discpak swivel joint.

REPLACE SEALS WITHOUT REMOVING JOINT FROM THE LINE

To replace the disc-seal, simply remove four allen screws and spread line slightly with a flat metal bar.

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New Discpak Bulletin 100 describes in detail the many features of this new swivel joint including full mechanical specifications.

57-26

Ammonia Capacity Covers the Nation as Round of Expansion Ends

		Thousand Tons
Allied Chemical & Dye	Hopewell, Va	395
Allied Chemical & Dye	South Point, Ohio	273
Allied Chemical & Dye	La Platte, Neb	75
American Cyanamid	Avondale, La	105
Ammonia Chem. of Calif	Huron, Calif	35[1]
Apache Powder	Benson, Ariz	10[2]
Atlantic Refining	Philadelphia, Pa	60[2]
Calumet Nitrogen Products	Hammond, Ind	105
Collier Carbon & Chemical	Brea, Calif	82
Columbia-Southern Chemical	Natrium, W. Va	25
Commercial Solvents	Sterlington, La	135
Cooperative Farm Chemicals	Lawrence, Kan	55
Deere	Pryor, Okla	63
Dow Chemical	Freeport, Tex	70
Dow Chemical	Midland, Mich	16
Dow Chemical	Pittsburg, Calif	7
Du Pont	Belle, W. Va	230
Du Pont	Niagara Falls, N. Y.	10
Escambia Chemical	Pace Junction, Fla	88
Grace Chemical	Memphis, Tenn	87
Hercules Powder	Hercules, Calif	50
Hercules Powder	Louisiana, Mo	42
Hooker Electrochemical	Tacoma, Wash	22
Ketona Chemical	Ketona, Ala	45
Mississippi Chemical	Yazoo City, Miss	98
Mississippi River Chemical	Selma, Mo	70
Monsanto Chemical	El Dorado, Ark	210
Monsanto Chemical	Luling, La	105
Northern Chemical Industries	Searsport, Me	44
Olin Mathieson Chemical	Lake Charles, La	110
Olin Mathieson Chemical	Niagara Falls, N. Y.	7
Olin Mathieson Chemical	Morgantown, W. Va.	230
Pennsalt Chemicals	Wyandotte, Mich	33
Pennsalt Chemicals	Portland, Ore	6
Petroleum Chemicals	Lake Charles, La	100[2]
Phillips Chemical	Etter, Tex	160
Phillips Chemical	Houston, Tex	157
Phillips Pacific Chemical	Pasco, Wash	70
Rohm & Haas	Deer Park, Tex	50
San Jacinto Chemical	Houston, Tex	40
Shell Chemical	Pittsburg, Calif	105
Shell Chemical	Ventura, Calif	60
Southern Nitrogen	Savannah, Ga	88
Spencer Chemical	Military, Kan	180
Spencer Chemical	W. Henderson, Ky	70
Spencer Chemical	Vicksburg, Miss	70
St. Paul Ammonia Products	St. Paul, Minn	70
Sohio Chemical	Lima, Ohio	105
Standard Oil of California	Richmond, Calif	105
Sun Oil	Marcus Hook, Pa	105
Tennessee Valley Authority	Wilson Dam, Ala	91
Texas Co	Lockport, Ill	63[2]
U. S. Industrial Chemicals	Tuscola, Ill	50
U. S. Steel	Geneva, Utah	70
Westvaco Chlorine Products	S. Charleston, W. Va.	21
Total		**4793**

[1] Planned; [2] Due this year; [3] Under construction.

of pounds (3.3 million tons produced in 1956). Methane or natural gas is the most important source of hydrogen for ammonia, accounting for over three-quarters of all the hydrogen used for this purpose. Recently, by-product hydrogen made in the refinery catalytic reformers has become a significant source and by 1958 should account for almost 10%.*

▶ **Petro-Ammonia**—This hydrogen is cheap. But another important significance is that for the first time the petroleum industry, is competing in the ammonia-and-derivatives markets in a big way. Large producers—such as Petroleum Chemicals, Inc., Standard Oil of Indiana, Sinclair Oil Co., Sun Oil Co., Standard Oil of California—could be instrumental in changing the competitive pattern of the industry considerably.

Of all chemicals, ammonia has probably received the most discussion since the end of World War II. It continues to be the dominant source of fixed nitrogen in the United States. In its many forms, ammonia is used as the primary source of nitrogen by the fertilizer industry, where approximately 70% of the output is consumed.

Capacity to produce ammonia is at least 30% above requirements and largely for this reason a substantial quantity—about 10% of the output—is now exported. Actually, most of this exported nitrogen is also used in fertilizers, so that 80% of all ammonia eventually is used for agricultural purposes.

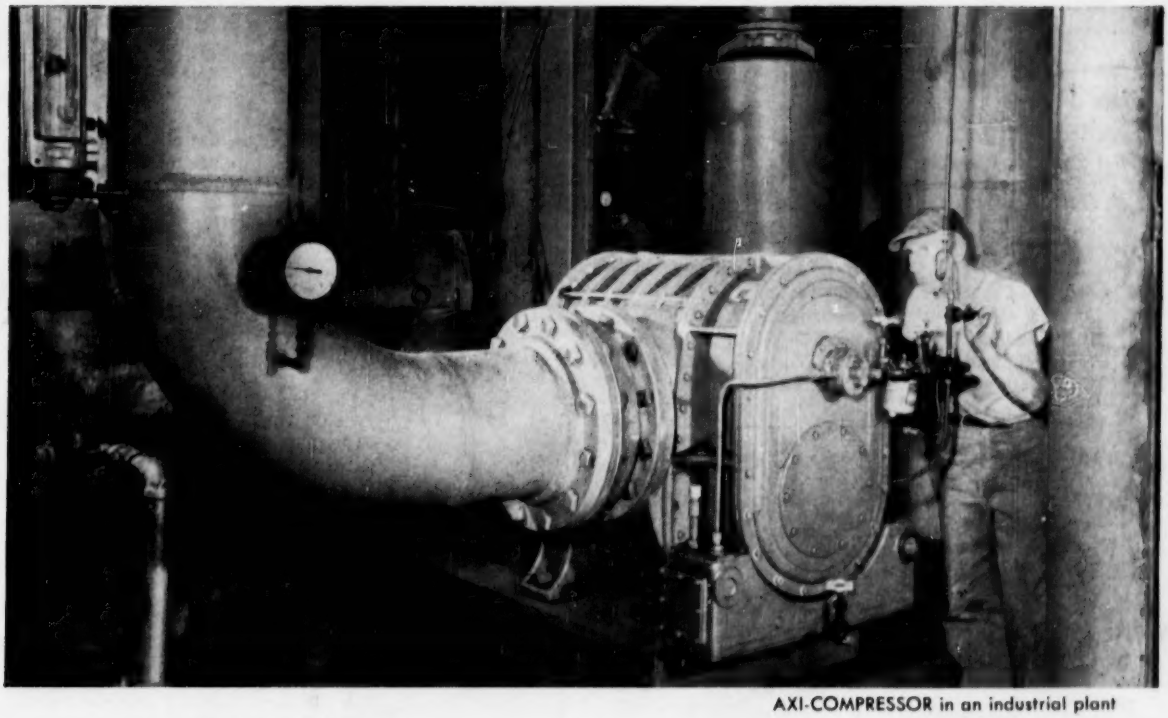
While industrial uses for explosives, synthetic fibers, paper pulping, and the like are increasing, no combination of these uses is likely to be as massive as fertilizer. And agricultural outlets in the future may consume an even larger portion of the ammonia output.

▶ **Ammonia Everywhere**—An important change in the industry in the last five years has been the rearrangement in geographical distribution of plants. Today the ammonia industry is approaching the sulfuric acid industry in terms of wide distribution of facilities. This change has brought sharp increases in the freight-equalization costs of many older producers.

In the fertiiizer market some changes in preference for ammonia derivatives are also occurring. Straight materials such as anhydrous ammonia, solutions, solid ammonia nitrate, and urea continue to account for increasing quantities of nitrogen at the expense of that contained in mixed fertilizers. Boasting a high fixed-nitrogen content of 45%, urea has shown a sharp increase in demand—largely at the ex-

* This is as much as all byproduct hydrogen (5.4% electrolytic, 4.5% refinery) accounted for last year. In 1958 byproduct hydrogen will sire 18% of ammonia production (electrolytic, 4.5%; coke oven gas, 2.4%; acetylene from natural gas, 1%; refinery, 10%).

Most compact compressor of its type . . .



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for pressure and vacuum . . .
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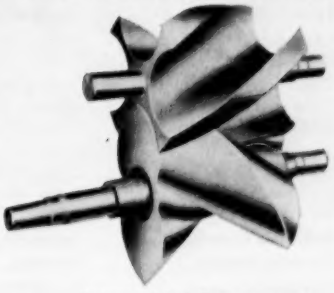

Rotors of Axi-Compressor

If you are looking for a compact, efficient source of pressure or vacuum, investigate AXI-COMPRESSORS: they provide greater output per pound of unit. AXI-COMPRESSORS may be operated efficiently over a wide range, with low power consumption.

Rotors are of cycloidal form, screw type. They operate with clearances of a few thousands of an inch, but never touch . . . there's no need for internal lubrication.

Operating advantages of this axial-flow, positive-displacement unit includes the following:

1. Compact, rugged construction
2. Smooth, shockless flow
3. No metal-to-metal contact in compression chamber
4. Operating speeds that permit direct-connected drivers in many cases
5. Oil-free delivery
6. Good efficiency over wide range

For complete information on the AXI-COMPRESSOR line for pressures from 25-inch vacuum to 15 psi, capacities from 100 cfm to 15,000 cfm . . . contact your Ingersoll-Rand compressor specialist. Performance curves available in Bulletin 11,001 . . . write for it.

*Axi-compressor
. . . formerly "Standardaire"

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pense of ammonium nitrate. Urea-containing solutions for direct application also are becoming popular.

Large price reductions in ammonia are not anticipated, in spite of the big overcapacity for ammonia and its consequent weak market position compared to that of three or four years ago. Ammonia production is inherently a high-investment operation and ammonia plants have a rather high break-even point. Profitability on new plants is not high at the present prices and the magnitude of any price reductions should reflect these factors.

Acrylonitrile Capacity Heads for 300 Million Pounds

		Capacity Today	Building Begun	Plans Announced
American Cyanamid	Fortier, La.	50		50
American Cyanamid	Warners, N. J.	35*		
B. F. Goodrich	Calvert City, Ky.	25		
Monsanto Chemical	Texas City, Tex.	60	40	
Union Carbide	Institute, W. Va.	35	35	
Total capacity, million lb.		**205**	**75**	**50**

* Expected to close upon completion of Fortier addition.

Methanol-Formalin Capacity: Resin Demand is the Goad

		Methanol (Million Gal.)	Formalin (Million Lb.)
Allied Chemical & Dye	South Point, Ohio	38	200
Borden	Demopolis, Ala.	...	
Borden	Bainbridge, N. Y.	...	
Borden	Springfield, Ore.	...	200
Borden	Kent, Wash.	...	
Borden	Fayetteville, N. C.	...	
Celanese	Bishop, Tex.	15	235
Celanese	Pampa, Tex.	small	...
Commercial Solvents	Sterlington, La.	40	30
Commercial Solvents	Agnew, Calif.	...	15
Commercial Solvents	Peoria, Ill.	2	...
Du Pont	Belle, W. Va.	50	235
Du Pont	Orange, Tex.	40	...
Du Pont	Perth Amboy, N. J.	...	150
Du Pont	Toledo, Ohio	...	60
Escambia Chemical	Pensacola, Fla.	16*	...
Hercules Powder	Louisiana, Mo.	7*	...
Heyden-Monsanto	Texas City, Tex.	25	...
Heyden-Newport	Garfield, N. J.	...	175
Heyden-Newport	Fords, N. J.	...	60
Hooker Electrochemical	N. Tonawanda, N. Y.	...	90
Kay-Fries Chemical	W. Haverstraw, N. J.	...	15
Merck	Danville, Pa.	...	400
Monsanto Chemical	Indian Orchard, Mass.	...	160
Olin Mathieson Chemical	Morgantown, W. Va.	33	50
Rohm & Haas	Houston, Tex.	15*	...
Rohm & Haas	Bristol, Pa.	...	25
Rohm & Haas	Bridesburg, Pa.	...	25
Reichhold Chemicals	Tacoma & Seattle, Wash	...	
Reichhold Chemicals	Ballardvale, Mass.	...	
Reichhold Chemicals	Charlotte, N. C.	...	140
Reichhold Chemicals	Tuscaloosa, Ala.	...	
Spencer Chemical	Calumet City, Ill.	...	35
Spencer Chemical	Pittsburg, Kan.	10	...
Trojan Powder	Seple, Pa.	...	40
Union Carbide	S. Charleston, W. Va.	12	...
Union Carbide	Texas City, Tex.	18	...
Union Carbide	Boundbrook, N. J.	...	140
Warren Petroleum	Conroe, Tex.	4	...
Total		**325**	**2480**

* Under construction.

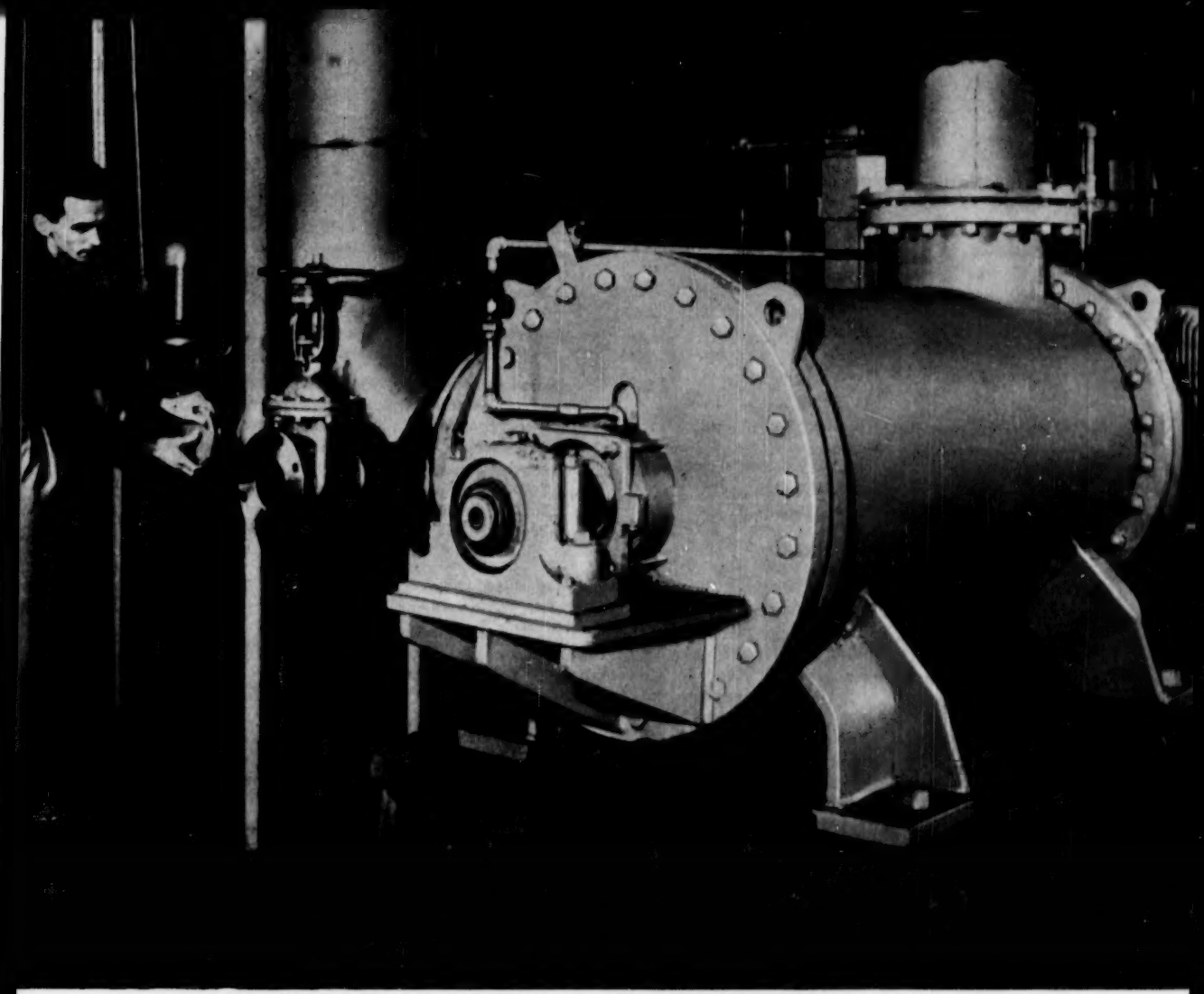
While methanol's end-use pattern has changed sharply in the past two years, its market continues to be rather strong. Consumer demand for methanol as an antifreeze has declined abruptly as motorists have shown a very strong and growing preference for the nonvolatile products based on ethylene glycol. Formerly, about 30% of the methanol produced went to antifreeze; only about 10% is now used for this purpose.

Market volume has been sustained by the upward demand for formaldehyde, methanol's largest end use. Export markets also have increased. Both these factors have been important market-stabilizers during the change in the pattern of consumption.

Methanol now accounts for about 85% of all the formaldehyde produced, increasing its portion of the formaldehyde market about 10% in the last two years. Demand for various phenolic, urea and melamine resins has grown rapidly, upping requirements for formaldehyde (formalin output jumped from 1.0 billion lb. in '54 to 1.6 billion lb. last year) and for methanol.

▶ **Methanol's Uses Shift**—Methanol, which with some engineering changes can be produced in an ammonia plant, continues to be the second most important petrochemical based on methane. Overcapacity is not great, only about 20%. But after two or three of the new plants are placed on stream an additional 10% overcapacity probably will become available. Output in 1956 was about 256 million gal., about two-thirds from natural gas.

▶ **Hydrocarbon Acetylene**—Although commercial exploitation of processes to make acetylene from methane has lagged behind technical knowledge available after the end of World War II, hydrocarbon-based processes are now becoming important commercially. Three plants, operated



Chlorine dioxide mixer in service at the Carolina Division of Riegel Paper Corp. The unit was manufactured by Improved Machinery Inc. It is lined with ⅛" Rem-Cru A-70 titanium sheet.

Titanium liner gives low-cost protection to a conventional metal

Even a small amount of titanium can protect an entire unit from corrosion damage. Here's an example...

Highly corrosive chlorine dioxide would quickly ruin the conventional material in the mixer shown above. So, titanium, virtually immune to such attack, was used to form a protective liner. Sheets of ⅛" thick Rem-Cru titanium were welded together and formed into a cylinder, which was "rolled in" to fit the mixer shell tightly. A full year's trouble-free service again shows titanium to be the least expensive metal in terms of service life.

Titanium has many other advantages. It's as strong as steel, for example, yet 44% lighter. And it's a practical way to extend service life by as much as 10, 20, even 50 times. Why not let a qualified Rem-Cru engineer help you work out specific applications.

REM-CRU TITANIUM

World's Most Versatile Metal

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Chloromethane Producers: Kolker and Frontier Join the Ranks

Methyl Chloride (1956 Output: 41.6 million lb.)

Allied Chemical & Dye	Moundsville, W. Va.
Ansul Chemical	Marinette, Wis.
Diamond Alkali	Belle, W. Va.
Dow Chemical	Freeport, Tex.
Dow Corning	Midland, Mich.
Du Pont	Niagara Falls, N. Y.
General Electric	Waterford, N. Y.
Kolker Chemical	Newark, N. J.

Methylene Chloride (1956 Output: 95.4 million lb.)

Allied Chemical & Dye	Moundsville, W. Va.
Diamond Alkali	Belle, W. Va.
Dow Chemical	Freeport, Tex.
Du Pont	Niagara Falls, N. Y.
Kolker Chemical	Newark, N. J.
Frontier Chemical	Wichita, Kan.

Chloroform (1956 Output: 46.3 million lb.)

Allied Chemical & Dye	Moundsville, W. Va.
Diamond Alkali	Belle, W. Va.
Dow Chemical	Freeport, Tex.
Du Pont	Niagara Falls, N. Y.
Frontier Chemical	Wichita, Kan.
Kolker Chemical	Newark, N. J.

Carbon Tetrachloride (1956 Output: 302.5 million lb.)

Allied Chemical & Dye	Moundsville, W. Va.
Diamond Alkali	Painesville, Ohio; Belle, W. Va.
Dow Chemical	Freeport, Tex.; Pittsburg, Cal.
Frontier Chemical	Wichita, Kan.
Kolker Chemical	Newark, N. J.
Stauffer Chemical	Niagara Falls, N. Y.; Louisville, Ky.
Westvaco Chlorine Products	S. Charleston, W. Va.

by Monsanto, American Cyanamid, and Union Carbide, are making acetylene from natural gas. Combined output accounted for about 10% of the 635 million lb. produced last year. Five additional plants are now under construction or in the final planning.

Calcium carbide, of course, continues to be the dominant acetylene raw material and will likely retain the lion's share of the market for several years.

An interesting modification that might develop in the hydrocarbon acetylene process derives from the interest of various potential producers in processes that make ethylene and acetylene as co-products from hydrocarbon cracking.

Neoprene continues to be the leading chemical outlet for acetylene, having grown appreciably in recent years in both solid and latex forms. Non-chemical uses, while growing, account for about 10% less of the acetylene consumption than 5-7 years ago. Vinyl chloride, third largest user of acetylene, seems to be coming more and more via the acetylene route, although appreciable quantities of this material are also based on ethylene.

▶ **Acrylonitrile: Best Bet**—Among the smaller uses, acrylonitrile should show the largest gain, particularly since the acrylonitrile-based fibers appear to have finally won consumer acceptance; several new fibers will become available soon.

Emphasis in acrylonitrile synthesis is shifting to the acetylene route; two-thirds of last year's output of 141 million lb. was derived in this manner. In 1954 ethylene oxide accounted for more than half of U. S. acrylonitrile.

Hydrogen cyanide made from natural gas became available about five years ago. Much of the HCN previously came from black cyanide and from the sodamide and formamide processes. Black cyanide continues to be an important source of the cyanide ion, but indications are that most new operations will be based on the process utilizing ammonia and natural gas.

Two uses of most promise for HCN are acrylonitrile and adiponitrile, both used primarily in synthetic fibers. Other uses for cyanides—such as electroplating, iron cyanides, dyes, and fumigants—are not likely to show spectacular gains but will grow proportionately to the economy.

▶ **Chloromethanes Still Grow**—Chloromethanes continue to be a sizable chemical use for methane. Direct chlorination of methane to carbon tetrachloride, chloroform, methylene chloride, and methyl chloride is practiced by Dow Chemical, Allied Chemical, Diamond Alkali, and Frontier Chemical. All other producers except Stauffer Chemical use the methanol chlorination process.

Carbon tetrachloride's older outlets—drycleaning, fire-extinguisher fluids, metal degreasing and other solvent uses—have slipped in importance compared to its use as an intermediate to chlorofluorocarbon aerosol propellants and refrigerants. Propellants, in turn, are the most important outlet for the carbon-tet-based chlorofluorocarbons, running better than 75 million lb./yr.

Chloroform's largest use, accounting for more than one-half of production, is likewise for chlorofluorocarbons, but in this case refrigerants are the more significant market. Requirements to make Du Pont's Teflon resin are small. Chloroform consumption in the synthesis of other chemicals has declined.

There's still active demand for methylene chloride, particularly for paint and varnish stripping (government requirements remain a significant factor). Methylene chloride also finds important use as a aerosol-propellant diluent and as a solvent for triacetate film and fiber.

Silicone production dominates demand for methyl chloride. Butyl rubber production is the second most important end use; here methyl chloride serves as a solvent and catalyst carrier in polymerization. Fire-extinguisher-fluid outlets have declined.

Chemical Consumption Index
(1935 = 100)

July 1957 (Final)	287
August 1957 (Est.)	307

Look for industry details next month.

When piping changes direction, protect process equipment with

ZALLEA SELF EQUALIZING UNIVERSAL EXPANSION JOINTS

Zallea Self Equalizing Universal Expansion Joints absorb any movement in any direction . . . axially, laterally, angularly, or any combination of these . . . making them ideal for protecting process vessels and rotating equipment from thermal expansion of connected piping.

When there is a leg or 90° offset to a long run of pipe, one Zallea Universal Expansion Joint will frequently take care of the entire system.

Under conditions of low load requirement for anchors or equipment . . . or when compressive loading in pipe walls must be kept to a minimum . . . Zallea Universal Expansion Joints are the most economical answer to the problem. They absorb the internal pressure thrust. The piping system need only carry the relatively small deflection loads.

Many types of Zallea Tied Expansion Joints are designed especially to absorb lateral deflection or rotation when there is pressure in the line. Universal, Modified Universal, Hinged, Gimbal, Pressure Balanced and Universal Pressure Balanced Expansion Joints give you a choice of the type best suited to your particular application.

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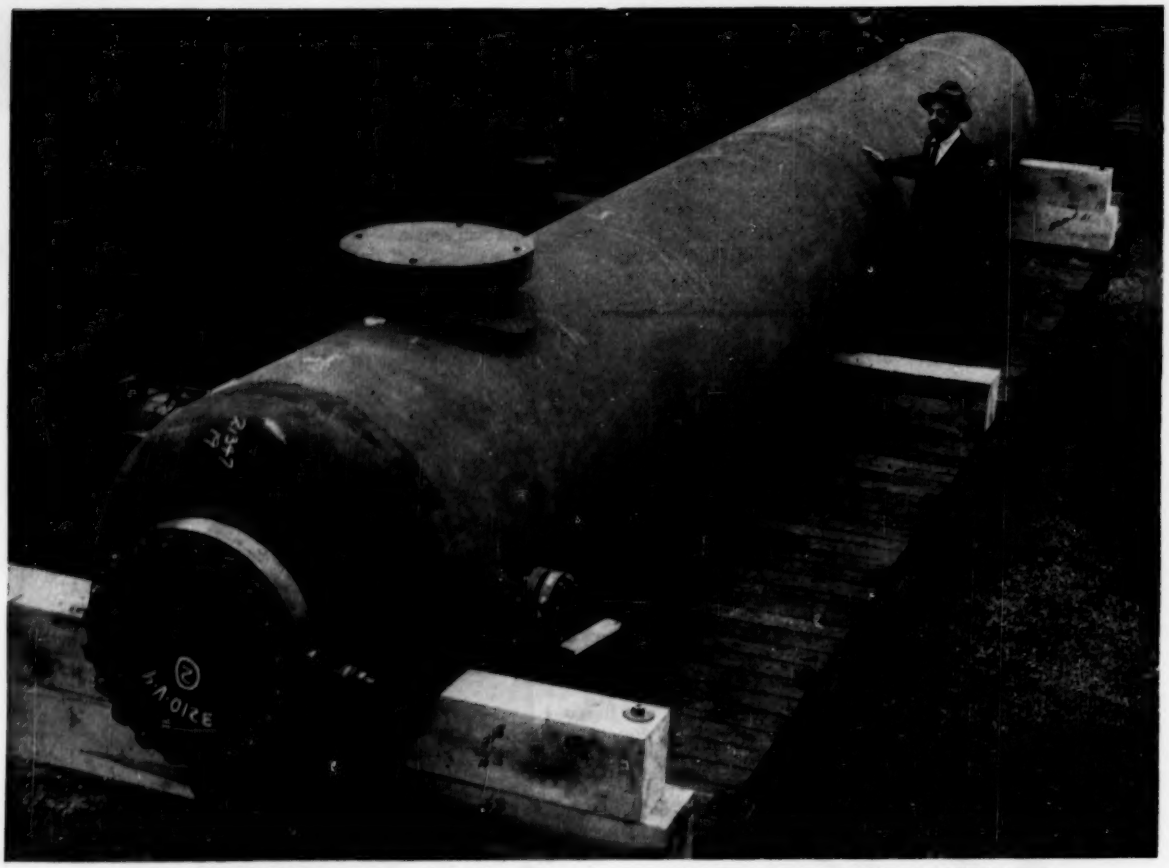
24" dia. Zallea Universal Self Equalizing Expansion Joints in service lines of the engine test facility of a West Coast aircraft manufacturer.



NEWPORT NEWS BUILT two 39'-7" horizontal gas scrubbers, such as this, for J. F. Pritchard & Co. They were made of ASTM-A212 Grade B fire box steel, with structural mesh steel interiors.

Gas scrubber made of 2⅞" steel

Newport News builds almost any type of pressure vessel and other heavy process equipment

Here is one of two horizontal gas scrubbers recently built for an operating pressure of 1800 psi at 300°F.

Newport News made both vessels from fire box steel, 2⅞ inches in thickness. We formed and automatically welded this steel into sections having a diameter of only 4 feet.

Rolling thick steel to this small diameter...no easy accomplishment, as you probably know . . . demonstrates the sort of jobs Newport News takes in stride.

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ROLLING 2⅞" STEEL for gas scrubbers. The steel, in a hot condition, was formed on the heavy bending equipment shown here. It will cold roll mild steel up to 3 inches thick, and will hot roll any grade of steel up to a thickness of 5 inches.

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with the Bailey Building Block Method

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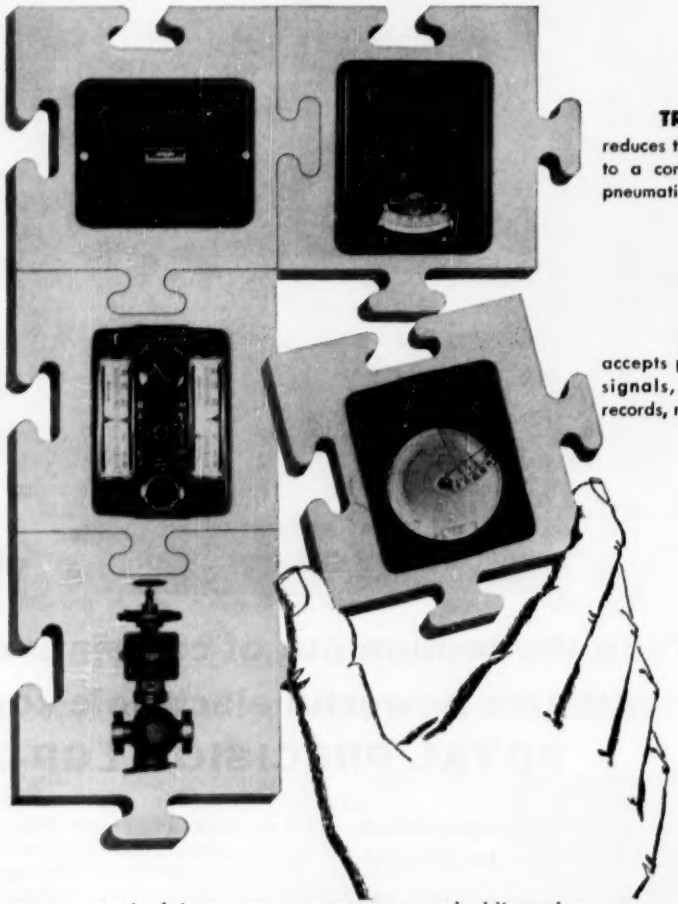
CONTROL RELAY
takes signals from the transmitter and computes corrective action in terms of pneumatic signals.

SELECTOR STATION
gives operator choice of hand or automatic control including set-point or bias adjustments.

POWER UNIT
is the "muscle" of the system. It performs whatever precise mechanical action is necessary to achieve control.



TRANSMITTER
reduces the measured variable to a common denominator, a pneumatic or electric signal.

RECEIVER
accepts pneumatic or electric signals, indicates and/or records, measurements.

Not all these components are required in every control system. You buy only what *your* system needs. When you change processes or add more automatic control, you can add additional standard components. Sometimes you may want to build a whole new system, re-using some of the existing components and adding other new ones. Spare parts inventory and maintenance training are reduced.

Hear the complete story of the Bailey Building Block System. Find how it can solve your control problems. See your Bailey Engineer or write for more information.

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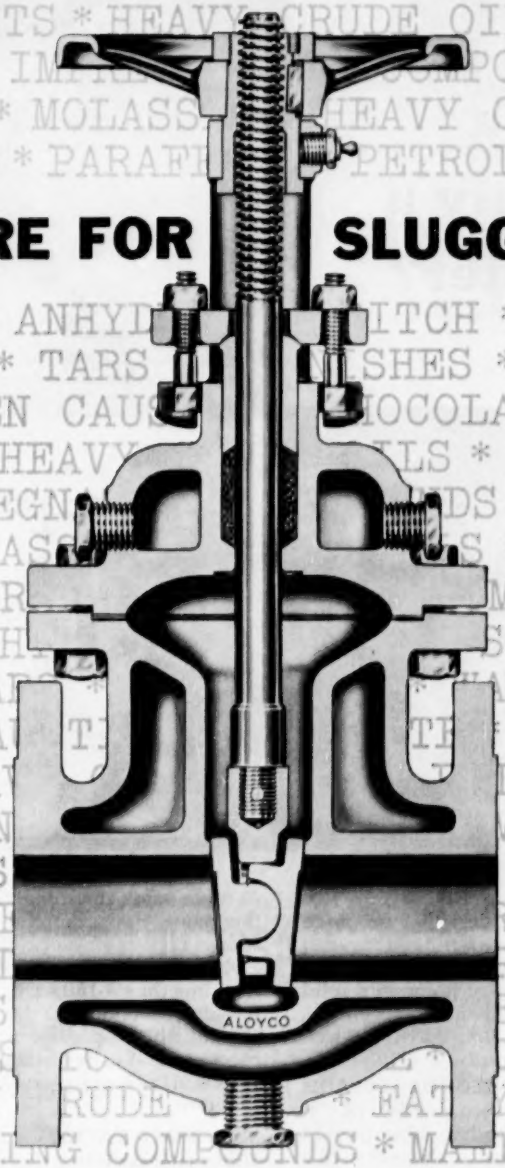

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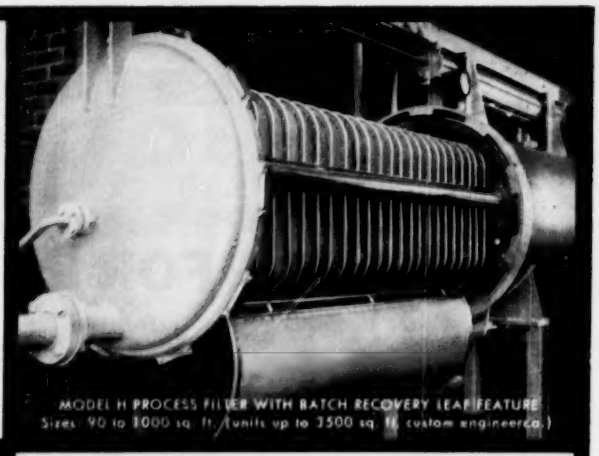
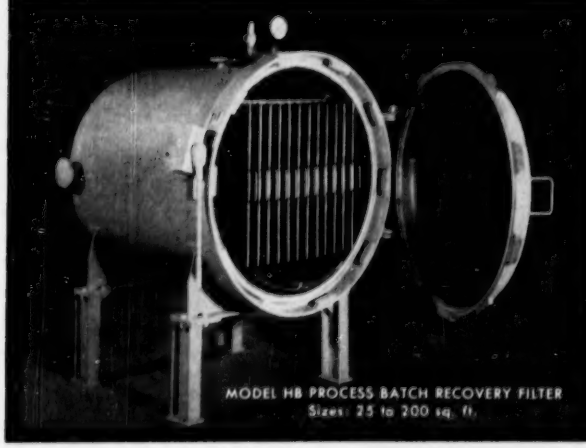
ALLOY STEEL PRODUCTS COMPANY

when is a filter truly a batch filter?



MODEL H PROCESS FILTER WITH BATCH RECOVERY LEAF FEATURE
Sizes: 90 to 1000 sq. ft. (units up to 3500 sq. ft. custom engineered)



MODEL HB PROCESS BATCH RECOVERY FILTER
Sizes: 25 to 200 sq. ft.

the PF answer:

when it filters
a complete preparation
down to the last drop!

That's exactly what these PF Filters are equipped to do. Especially designed for large and small batch filtering operations, they can be profitably utilized in continuous processes which involve a wide variety of liquid and solid separations. Processors who change products, formula and treatment will find that PF Batch Recovery Filters provide multiple advantages.

THERE'S NO WASTE — NO NEED FOR STORAGE! Featuring separately piped recovery leaves, PF Batch Filters are outfitted to handle unfiltered residue remaining in the tank at the end of the regular filtration cycle. The residue is filtered via blow-down rapidly down to practically the last drop in approximately the same time it would take to blow it back to a storage area . . . *and with less loss of residue.*

AND WHEN IT COMES TO PRODUCTIVITY . . . You can count on a PF Filter to boost your output in more ways than one. Start-up reports prove the point. For example: A 40 sq. ft. Process Model HB Filter clocked 1¾ hrs. in filtering a 2500 gallon batch — actually doing the job in less time than a 160 sq. ft. plate and frame filter. Residue remaining in the tank at the end of the regular filtration cycle was blown through the recovery leaf in five minutes. Cake discharge took 8 minutes.

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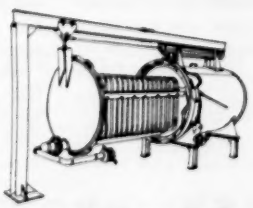
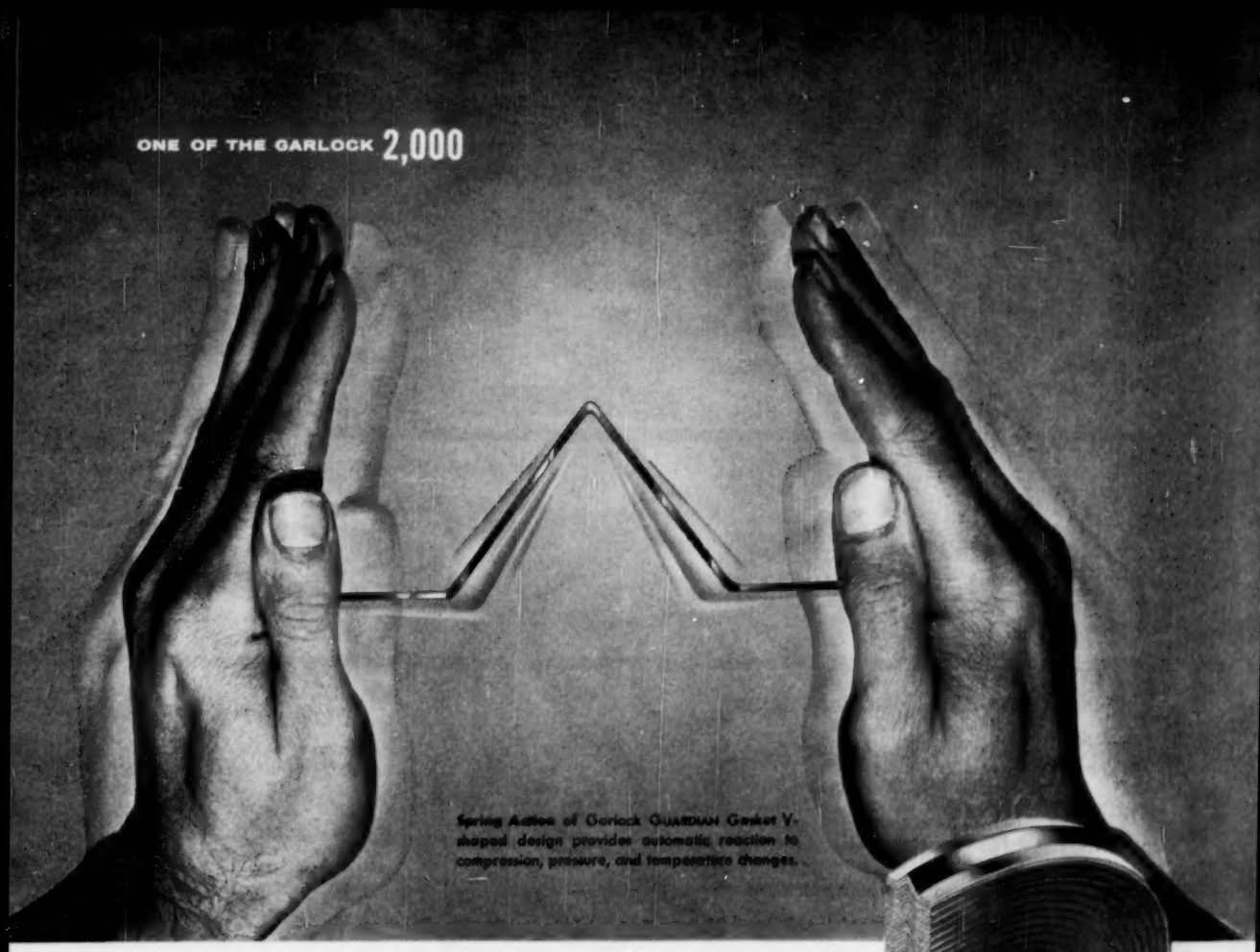
VERTICAL BATCH FILTERS



HORIZONTAL LEAF FILTERS

CARTRIDGE FILTERS

ONE OF THE GARLOCK 2,000



Spring Action of Garlock GUARDIAN Gasket V-shaped design provides automatic reaction to compression, pressure, and temperature changes.

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GUARDIAN Gaskets are another important part of the famous "Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet all your needs. The *only* complete line. That's why you get unbiased recommendations from your Garlock representative. Call him or write for new GUARDIAN Gasket Catalog AD-104.

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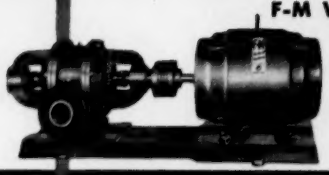
Guide to better pump selection

for		specify
boiler feed condensate return hot and cold liquids chemicals refrigerants, etc.	up to 200 gpm. pressures to 900 ft.	 **F-M WESTCO PERIPHERAL PUMPS** High pressure at normal operating speeds. Handle widely varying heads with little change in capacity. Sizes 1¼" through 2½".
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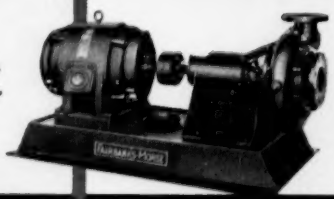
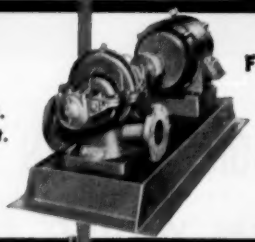
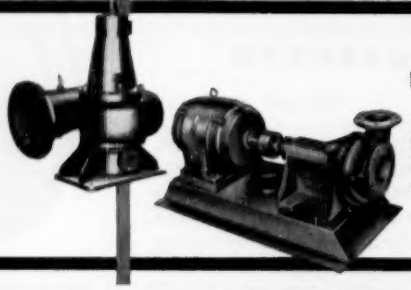
sewage slurries paper stock fruit shrimp vegetables, etc.	up to 30,000 gpm. pressures to 175 ft.	 **F-M NON-CLOG PUMPS** Unexcelled for clog-free handling of liquids with solids in suspension. Sizes 2" through 20". Vertical or horizontal. Bladeless or conventional.
water supply plant service booster circulating air conditioning refrigeration chemical liquids boiler feeds, etc.	up to 50,000 gpm. pressures to 700 ft.	 **F-M SPLIT-CASE CENTRIFUGAL PUMPS** High, sustained efficiency over wide range of conditions. Low-cost maintenance. Sizes 1½" through 36". Single stage or multistage.
hot and cold liquids chemicals circulating liquids nonviscous liquids cooling towers condenser circulation, etc.	up to 100,000 gpm. pressures to 250 ft.	 **F-M END-SUCTION PUMPS** A wide line of rugged, precision-built pumps. Sizes ¾" through 54". Horizontal or vertical centrifugal.

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MILLIONS OF SHARP, SUPERHEATED PARTICLES, traveling at high velocities, quickly wear dust collector linings, mains, downcomers, etc. Metals and most ceramics simply can't withstand this harsh abrasion. But CARBOFRAX refractories can—even at temperatures as high as 2500°F. A CARBOFRAX dust collector lining in an ore sintering machine is, for example, still in use after 10 years' service.

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Exceptional resistance to abrasion—whether caused by tiny gas-borne particles or sliding steel billets—is one of the most useful properties of several of Carborundum's unique refractory materials. For example, when used in the exhaust lines of gasoline catalytic cracking units in temperatures ranging up to 1200°F, these refractories lasted 3 years, as compared to alloy rings which lasted for 6 months.

And when abrasion is combined with higher temperature, the exceptional resistance of these super refractories becomes even more apparent and useful. As skid rails in furnaces which heat 6-lb. billets to 2250°F—pushing 250 slugs an hour—CARBOFRAX® silicon carbide refractories need one-third the replacement, one-third the labor and one-third the down-time of ordinary rammed chrome ore hearths. Other successful applications include: dust collectors, gas scrubbers, transfer pipe lines, hydro cyclones and process equipment parts, to name but a few.

Many applications call for other properties in combination with wear resistance. Among Carborundum's many materials are refractories that also offer excellent heat shock resistance with sufficient hot strength to withstand 25 psi at 3128°F. Others provide unique resistance to corrosion as well as abrasion. These properties are but a few of those to be found in super refractories pioneered by Carborundum. Among them, you are almost certain to find answers to your refractory and high-temperature problems. For help, fill in and mail this coupon:

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MAIL THIS COUPON TODAY

Dept. H127, Refractories Division,
The Carborundum Company, Perth Amboy, N. J.

Please send me:

- ☐ Forthcoming issue of Refractories Magazine
- ☐ Bulletin on Properties of Carborundum's Super Refractories
- ☐ Here is a description of my high temperature problem. Can you help me?

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world's

first!

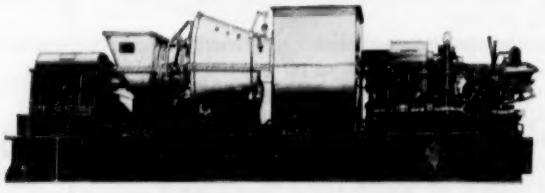
Westinghouse gas turbines in cat cracking process—reduce shutdown risk

WESTINGHOUSE GAS TURBINES are now driving air and gas compressors in a large cat cracking plant and three more are on the way to other plants owned by the same company. Another *World's First* for Westinghouse.

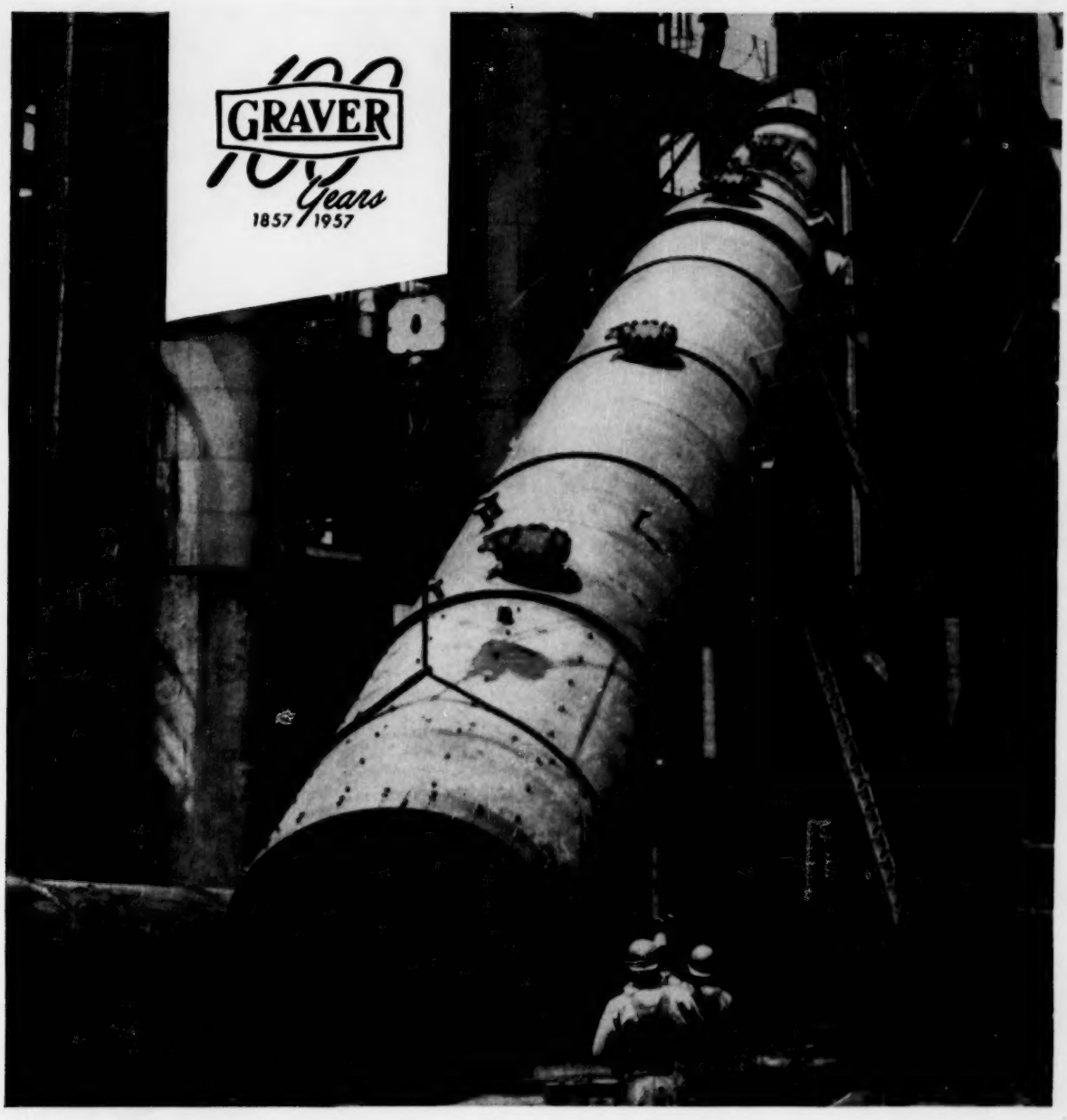
These gas turbine drives reduce the risk of shutdowns; using refinery gas as fuel, operation doesn't depend on other sources of fuel or on steam-generating equipment.

In addition to reliability, the Westinghouse gas turbine offers economy. Capital cost per horsepower is low, and since it's powered directly by refinery gas, there's no steam-generating equipment to buy, install and maintain. Operator payrolls? A few men can easily supervise the semiautomatic gas turbines. Installation? The self-supporting base eliminates the need for a bedplate and the unit may be installed outdoors.

Other Process Applications—Because the gas turbine furnishes shaft power, compressed air and hot gas up to 1000°F, it is used to streamline many processes. Ask today for a set of suggested process sketches. Contact your Westinghouse representative or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50599



YOU CAN BE SURE...IF IT'S Westinghouse



BIG GUN IN STAINLESS

Stainless steel so effectively turns the battle against corrosion that there is no question about the investment payout. To assure long life, Type 304 ELC stainless was selected for this 90′ stripper column. Shop-fabricated by Graver in two sections and field-welded into one unit, the column was random-radiographed and tested to pressures of 162 psi. and 246 psi. Graver's expertness in fabricating and welding stainless is always assurance of trouble-free service.

to turn the battle against corrosion!

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ALLOY DIVISION

Building for the Future on a Century of Craftsmanship in Steels and Alloys

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One of the world's two largest rotary-disk contactors is shown here in B-L-H's Eddystone Division fabricating shop. As on all Baldwin work, only qualified welders were employed.

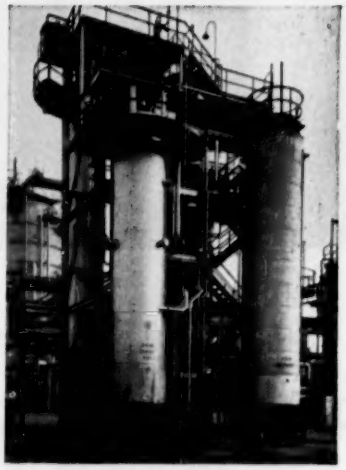
Baldwin fabricates world's biggest rotary-disk contactors

Baldwin-Lima-Hamilton's Eddystone Division, under contract with C. F. Braun and Company, engineers and constructors, recently built two 60-in. rotary-disk contactors, largest in the world. Of all-welded construction, both are over 60 ft. tall. They are used to remove sulfur compounds from natural gasoline and heavy naphthas produced in the crude oil distillation unit at the Tidewater Oil Co.'s Flying A Refinery near Delaware City, Del.

The enormous size of these structures was the source of the main fabrication problem. However, by using 100-ton Worthington drive rolls, Baldwin was able to position the vessels in welding. A huge 150-ton overhead crane moved them from place to place.

Both manual shielded metal arc and automatic submerged metal arc welding processes were employed, 95% joint efficiency in the welds being obtained. Bending, tensile and shear tests were conducted on test plates. The two vessels were subjected to Cobalt 60 radiographic inspection as well as magnetic particle inspection and were stress relieved at 1100°F in Baldwin's huge furnace. After being statically balanced the shafts were installed in the structures. Drive gears were then mounted and the contactors actually operated right in the shop.

These vessels are excellent examples of the kind of fabricating that only a shop with the superb facilities of B-L-H's Eddystone Division could accomplish. For a copy of our illustrated Weldment Bulletin 7001, write to B-L-H Corporation, Philadelphia 42, Pa.



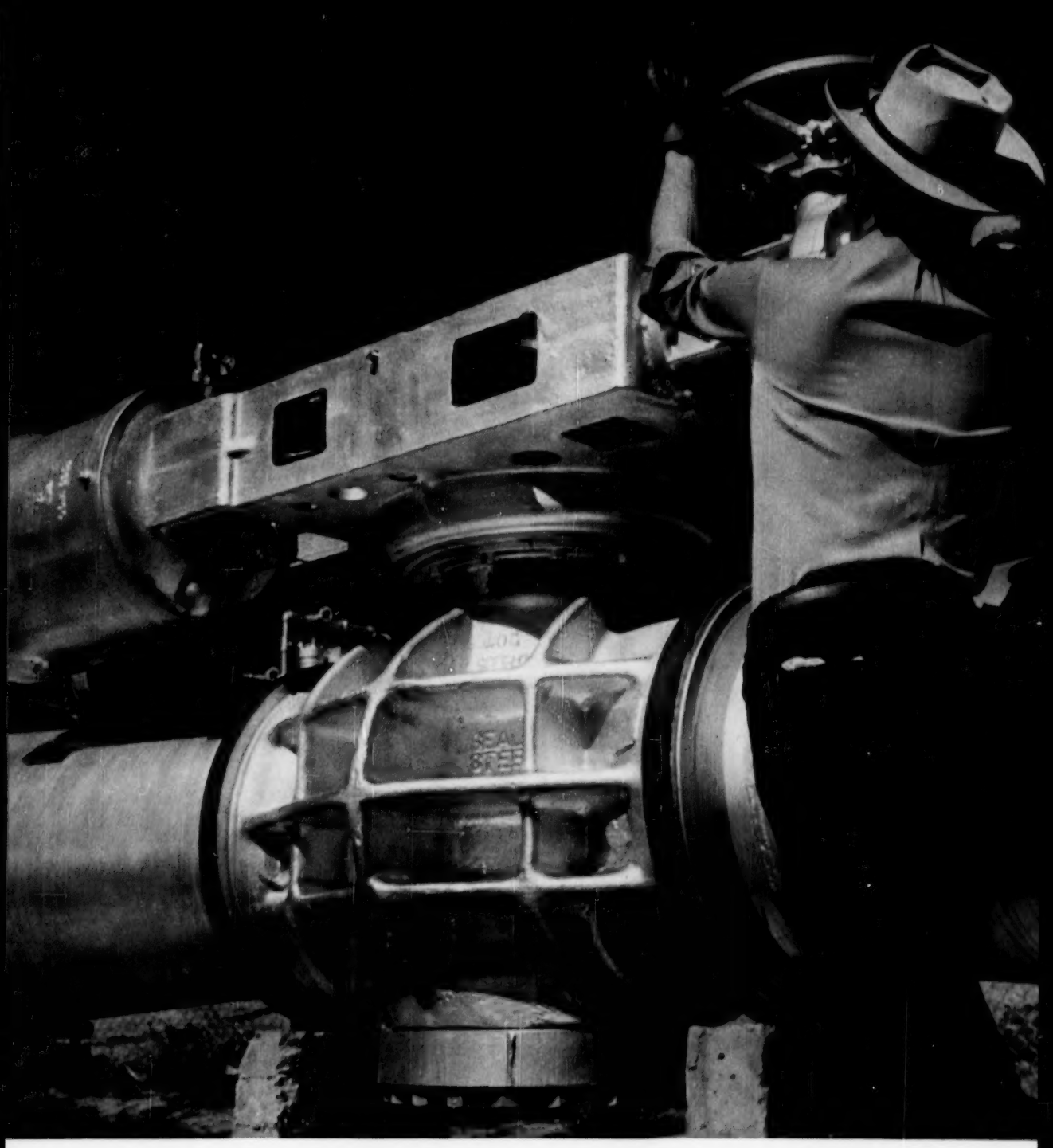
In operation at Tidewater Oil's Delaware refinery, these two rotary-disk contactors, which are of all-welded construction, are the largest in the world.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings



EMERGENCY! Are you sure your key valves will operate when an emergency comes? They will, *if* they are Rockwell-Nordstrom valves with *pressurized lubrication* that makes operation fast, easy and *sure*.

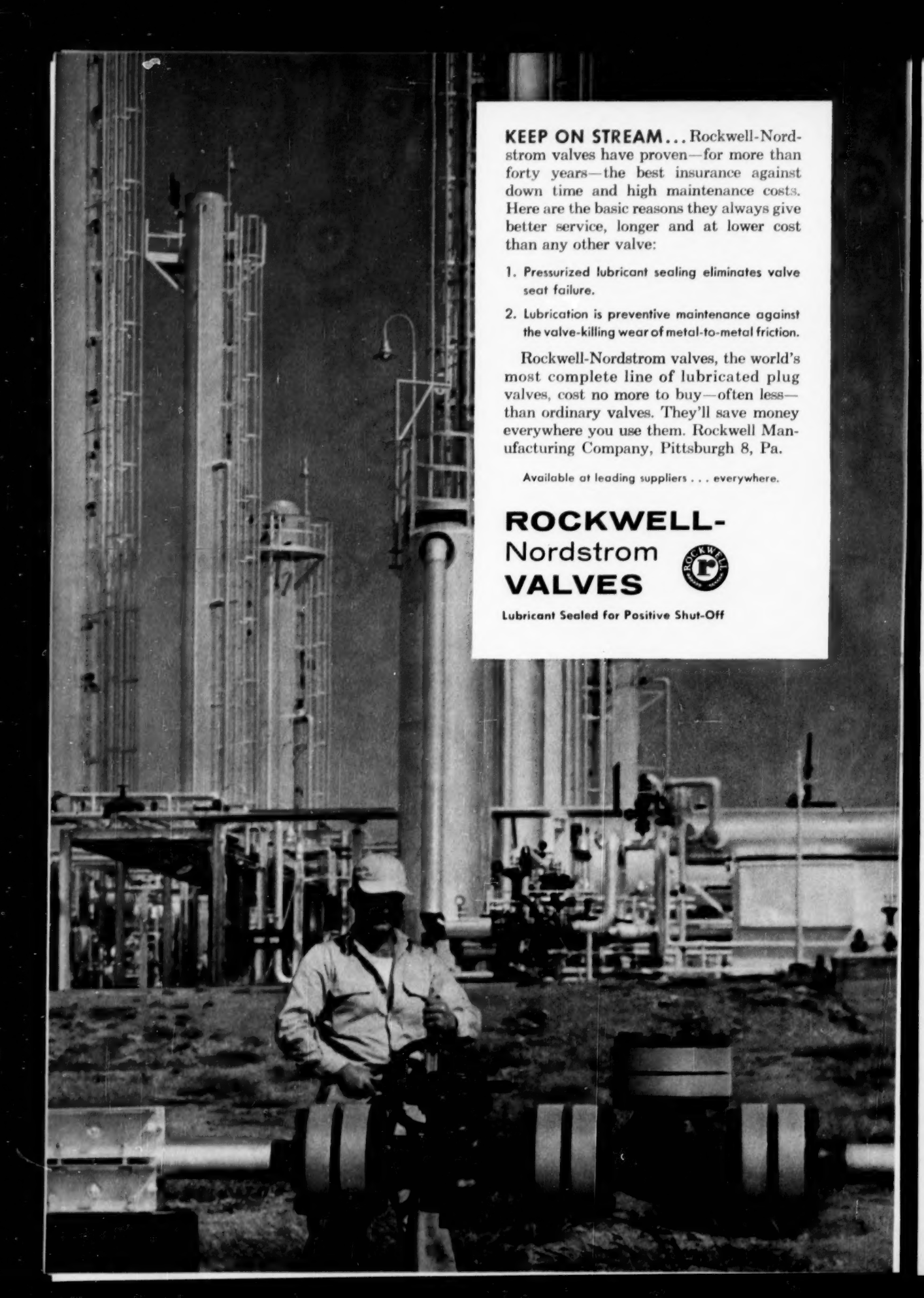
Unlike the forced seating in ordinary valves, the Rockwell-Nordstrom valve plug is kept friction-free by lubricant—frozen or stuck valves are eliminated. And quarter-turn closure is two to five times faster.

The lubricant in Rockwell-Nordstrom valves does another important job: it eliminates metal-to-metal wearing friction for longer valve life. Yet with all their obvious advantages, Rockwell-Nordstrom valves cost no more to buy, often less, than ordinary valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed For Positive Shut-Off



KEEP ON STREAM... Rockwell-Nordstrom valves have proven—for more than forty years—the best insurance against down time and high maintenance costs. Here are the basic reasons they always give better service, longer and at lower cost than any other valve:

1. Pressurized lubricant sealing eliminates valve seat failure.
2. Lubrication is preventive maintenance against the valve-killing wear of metal-to-metal friction.

Rockwell-Nordstrom valves, the world's most complete line of lubricated plug valves, cost no more to buy—often less—than ordinary valves. They'll save money everywhere you use them. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

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Nordstrom
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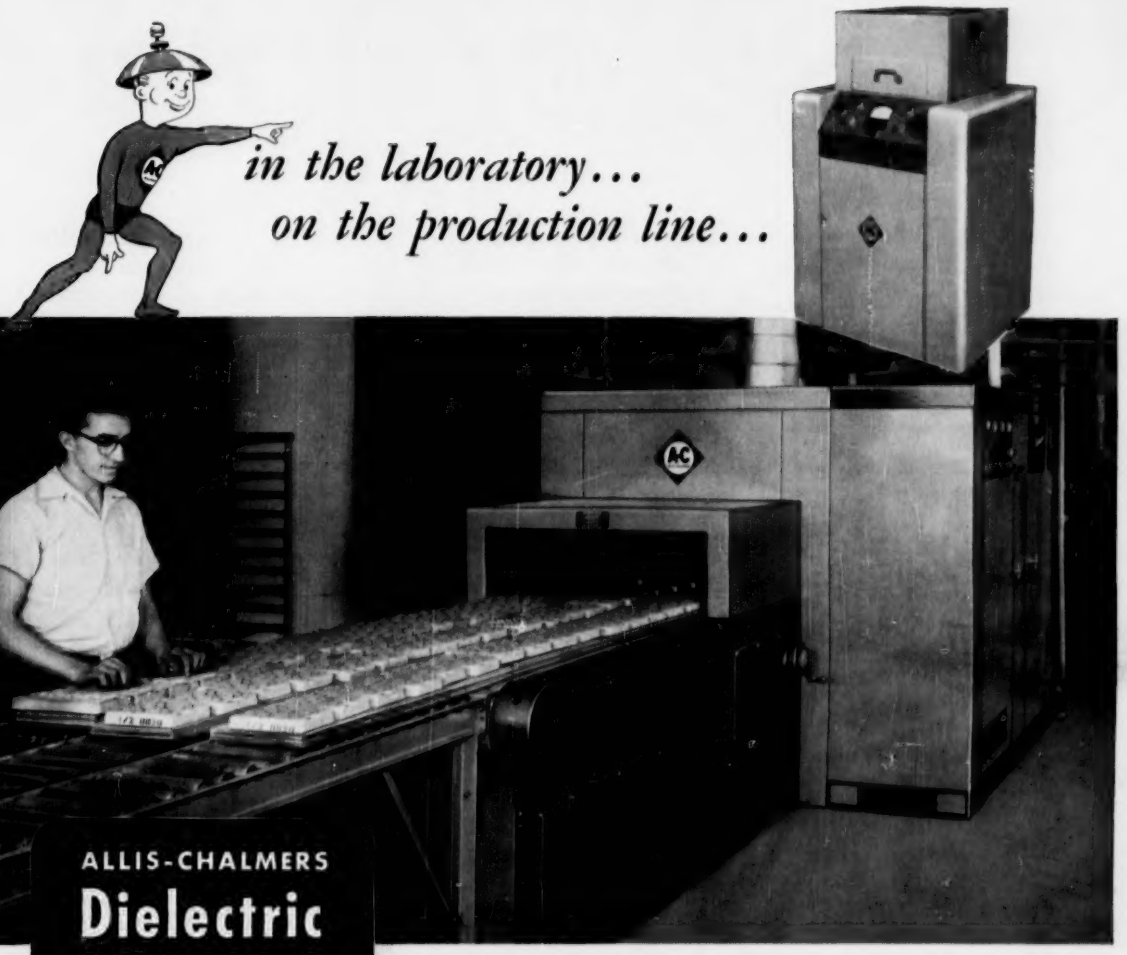
Lubricant Sealed for Positive Shut-Off



Solve a Wide Range of Industrial Heating Problems

Maybe you're looking for that better way to apply heat in your laboratory research projects. Or — you could be concerned with speeding up production in the plant. Regardless of your problem, chances are Allis-Chalmers dielectric heating engineers have solved an identical or very similar problem. This specialized engineering experience is at your disposal. Why not use it?

The Allis-Chalmers line of dielectric heaters for non-conducting materials extends from a 3-kw unit to 100-kw and larger machines. All sizes may be equipped with oven, cages, conveyors and other work handling accessories *designed by Allis-Chalmers* to meet your specific operating need.

For complete information, see your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. Ask for Bulletin 15B6431C.

ALLIS-CHALMERS

A-5302

Reaction over copper gets organochlorosilanes—the silicone building links . . .

. . . Hydrolysis, equilibration hook them into basic silicone polymers . . .

. . . Then, final tailoring steps produce prodigious array of silicone items.

For Host of Silicones: One Versatile Process

WITH AMAZING fertility, the silicone family keeps right on spawning new and vastly unalike offspring—from bouncing putty to lubricating greases to protective coatings and films. Thus conjecture might have it, in view of the secrecy long shrouding this field, that silicone technology includes a widely varied collection of processes.

Now General Electric Co. has allowed the first close look at its silicones operations at Waterford, N. Y. And, strikingly, it's seen that behind the manufacture of nearly 450 silicone products stands a single, basic and uncannily versatile processing technique.

As GE's Manager of Manufacturing Engineering, Erv Koeritz, puts it, "Our present operation, in effect, is just a more mature and highly exploited version of the pioneer process we first swung on stream back in 1948 to turn out a handful of products."

▶ **Process Basis: Direct**—What is the process? At the heart of GE's installation lies the so-called Direct Process for making alkyl and aryl chlorosilanes. Discovered by GE, it holds the key role in silicones manufacture over such competing routes as Wurtz and Grignard reactions by virtue of simplicity.

Silicon metal, in the presence of a copper catalyst, reacts with methyl chloride to produce a gas mixture of methylchlorosilanes— $(CH_3)_n(SiCl)_{4-n}$. After condensing, fractional distillation splits out the three chief ingredients — methyltrichlorosilane, dimethyldichlorosilane and trimethylchlorosilane.

These silanes represent the building links of the silicone (or siloxane) chains. By hydrolysing them cyclic and/or linear silicone polymers are produced. Then an equilibration reaction, run at elevated temperatures and in the presence of an acid or alkali catalyst, stabilizes, rearranges and generally tailors the polymer for specific applications.

▶ **Variations: Chemical**—All GE's silicone products fall into one of three broad categories—fluids, resins and elastomers. Depending on what variations it plays on the basic process theme, depends which category of silicone products GE will make.

For example, to make a silicone elastomer, GE hydrolyses dimethyldichlorosilane to yield the dimethyl silicone polymer. Equilibration reaction over acid or basic catalyst further polymerizes this chain to a 4,000-unit and longer silicone gum. Then fillers and other compounding and curing agents impart a variety of specific properties to the product.

Dimethyl silicone polymer enters in the manufacture of silicone fluids as well. In addition, trimethylchlorosilane is hydrolysed to produce hexamethylsiloxane. Together these silicones enter an equilibration reaction with either sulfuric acid or potassium hydroxide catalysts. There they co-polymerize. Dimethyl silicone represents the main links of the polymer.

Unfold Flowsheet

Hexamethylsiloxane, acting as a chain stopper, hooks on to the ends of this polymer to limit chain length to 3-9 units. From the resulting silicone oil comes GE's silicone greases, lubricants, polishes and waterproofing agents.

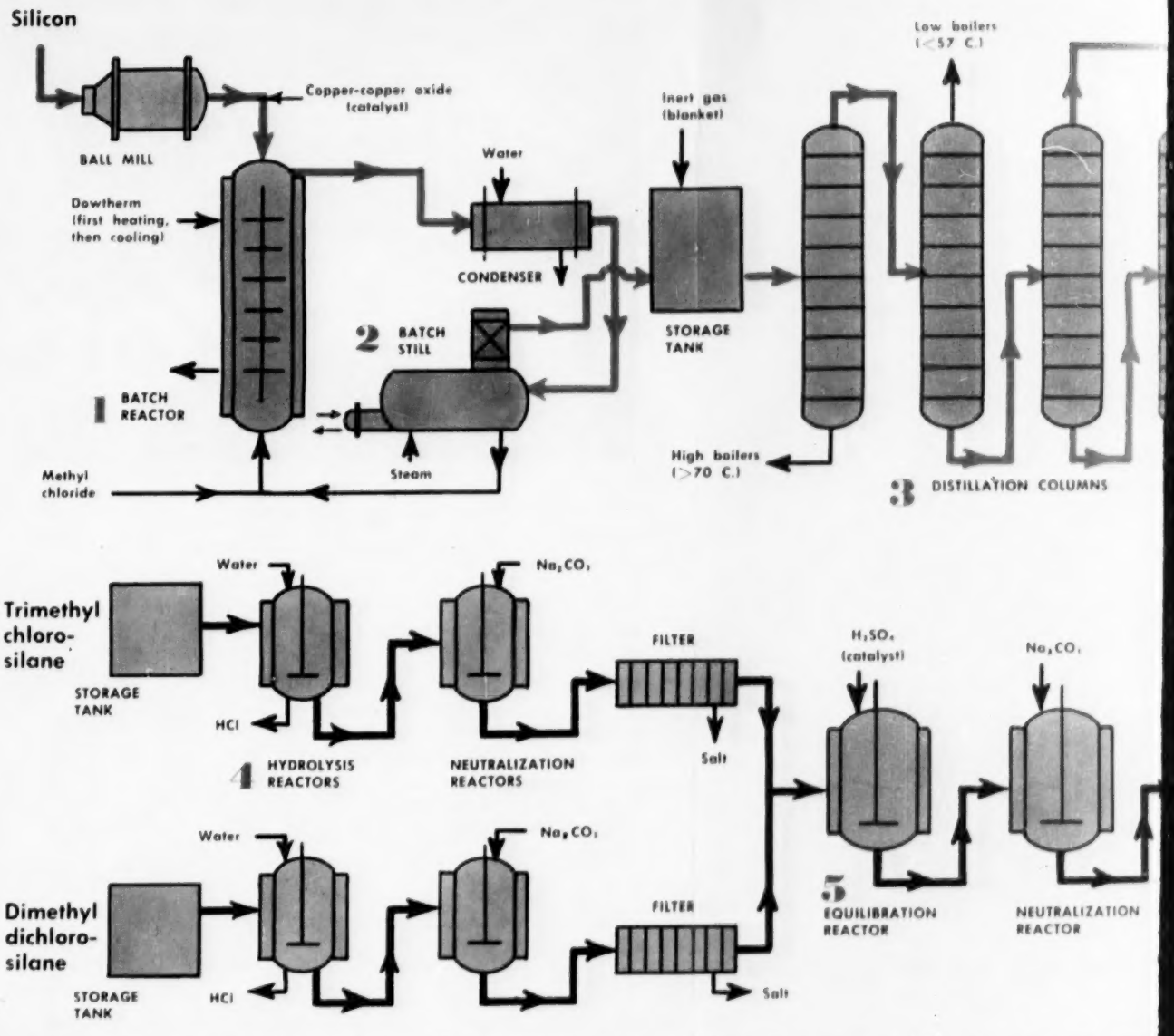
In processing to a silicone resin, GE starts with dimethyldichlorosilane, methyltrichlorosilane and corresponding phenyl chlorosilanes. They are mixed and hydrolysed together in a solvent medium (e.g., toluol) at elevated temperatures. Resulting co-polymer dissolves in solvent. Solvent is evaporated and during this stage silicone further polymerizes. From resins spring GE's silicone molding powders, varnishes, coatings, adhesives, etc.

▶ **Variations: Engineering** — While squeezing this versatility out of the chemistry of the process, GE has lavished attention on its engineering aspects as well. Chief current target: To convert all batch operations to a continuous basis wherever operating economies can be realized without sacrificing quality control.

Most recent advance to this goal is a continuous hydrolysis hook-up that can be used instead of big, jacketed batch kettles in the manufacture of silicone oils. It consists of a centrifugal pump, heat exchanger and decanter. Silanes, along with dilute HCl, enter this pump. There, thanks to the effective dispersion provided by the highspeed impeller, most of the hydrolysis takes place. Stream then flows through the cooler and recirculates in part to join fresh feed to the pump. A sidestream is tapped from this recycle and flows to the decanter where silicone oil is separated from HCl.

▶ **Flowsheet to Fluids**—For engineering details it's best to follow GE's flowsheet down one process route—the one to silicone oils.

Silicon metal (about 98% pure), delivered by railroad in 4-in. lumps, is first crushed, then milled to a powder. It's mixed with 5-10% by weight of a catalyst of copper powder and copper oxide. This solids stream is charged batchwise through a hopper to the top of the silanes reactor.



A typical reactor is a 15-ft.-high by 2-ft.-dia., Dowtherm-jacketed, carbon steel tower fitted vertically with a screw-type stirrer. Methyl chloride vapor, made at Waterford by reacting HCl and methanol, flows up the reactor countercurrent to the silicon-copper solids stream. To start the reaction, Dowtherm is used to heat reactor to about 300 C. But once it's underway, reaction is exothermic and Dowtherm becomes a cooling medium to keep reaction around 250-300 C. Pressure runs around atmospheric.

Gas phase overhead from the rector is condensed, then passes through a batch still where any unreacted methyl chloride is stripped from the mixed methylchlorosilanes. Silanes then go to storage under an inert-gas blanket which excludes air and moisture.

▶ **Silanes Separation, Hydrolysis** — From storage, silanes stream feeds on a continuous basis to four, series-hooked, atmospheric, bubble-cap distillation columns, ranging in height to 60 ft. First two columns split out low boiling (less than 55 C.) overheads and high boiling (more than 70 C.) bottoms. Third column yields trimethylchlorosilane overhead; fourth column splits out methyltrichlorosilane as overhead and dimethyldichlorosilane as bottoms. Each of these silanes is then stored. In the manufacture of silicone oils, dimethyldichlorosilane and trimethylchlorosilane represent the starting materials.

Dimethyldichlorosilane feeds with water to an agitated, waterjacketed batch hydrolysis reactor. GE uses glass-lined steel kettles, ranging in size from 20 to 500 gal. for this job. Exothermic reaction is controlled around 30-50 C., is essentially completed after several hr. Then agitator shuts off and reaction mass separates into an aqueous and oil layer. Aqueous layer 30% HCl, is dr or further proc

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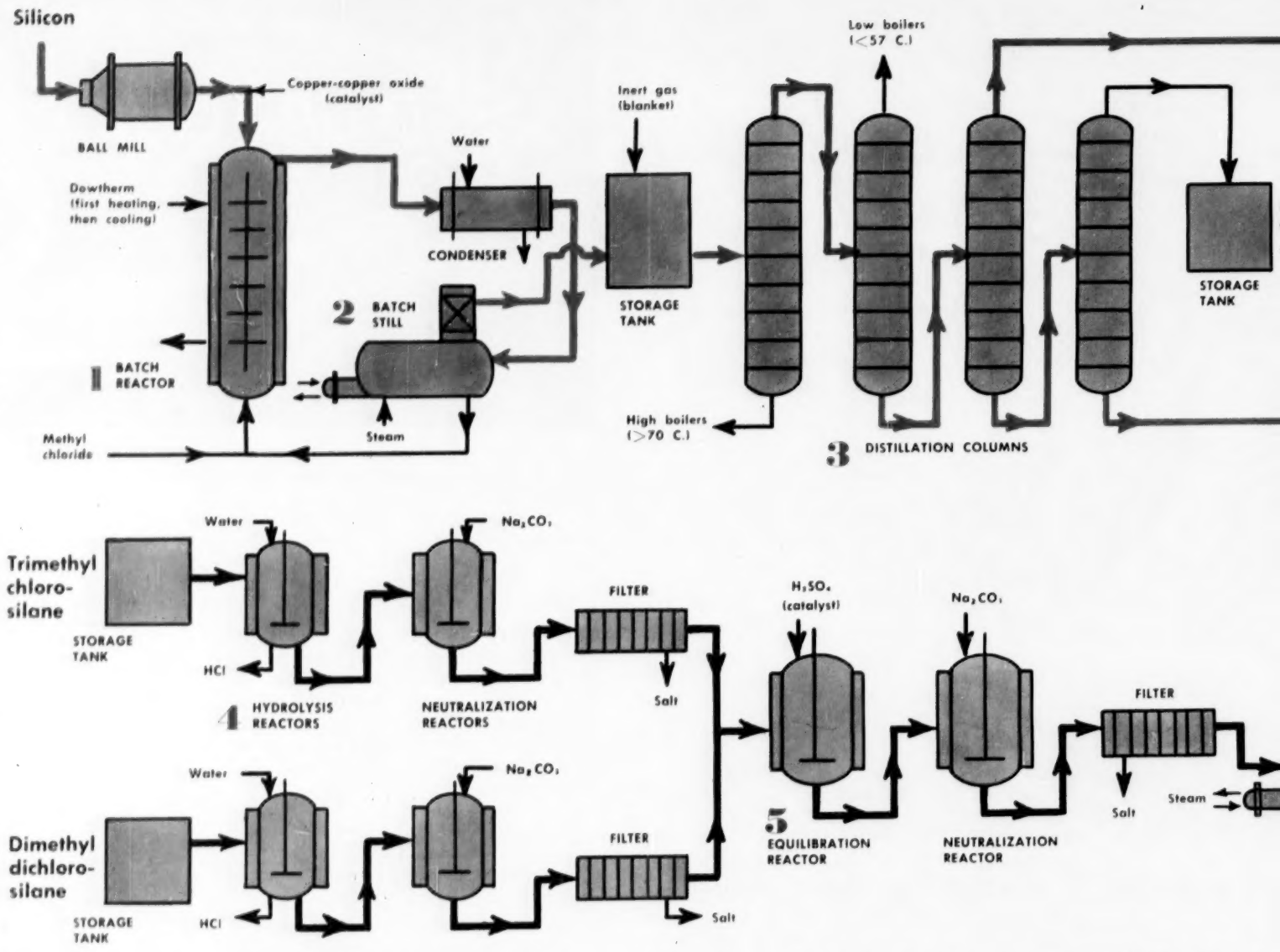

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Oil layer, consisting primarily of dimethyl silicone, goes to a neutralization stage. There, in a kettle almost identical to the hydrolysis reactor, sodium carbonate is agitated with oil to neutralize any by-product HCl carried over from hydrolysis reactor. Reaction mass then passes through screening and filtering steps to remove salts.

▶ **Equilibration** — An identical processing procedure occurs with the trimethylchlorosilane to produce hexamethylsiloxane. It then joins dimethyl silicone

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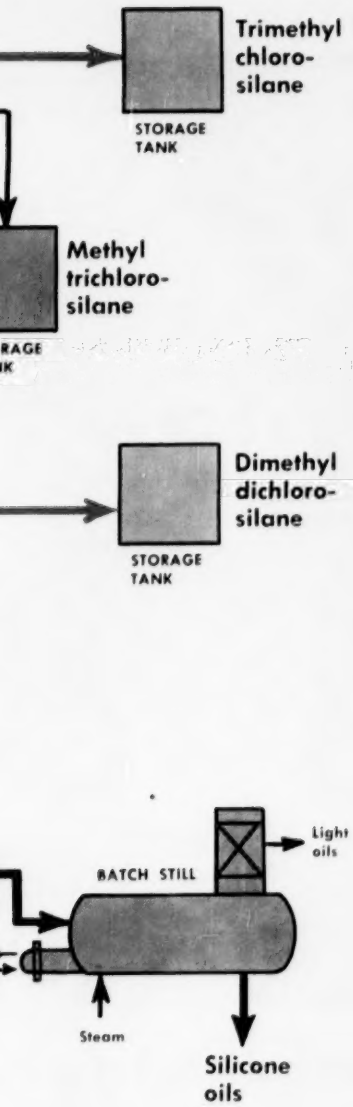
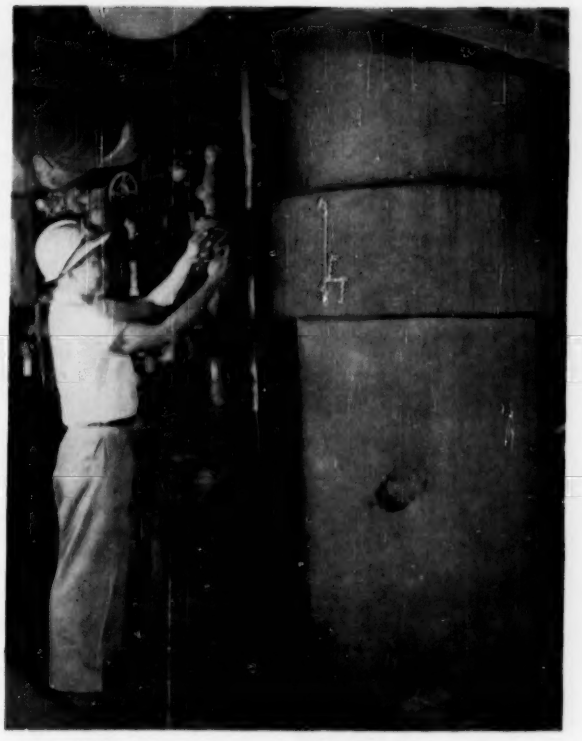
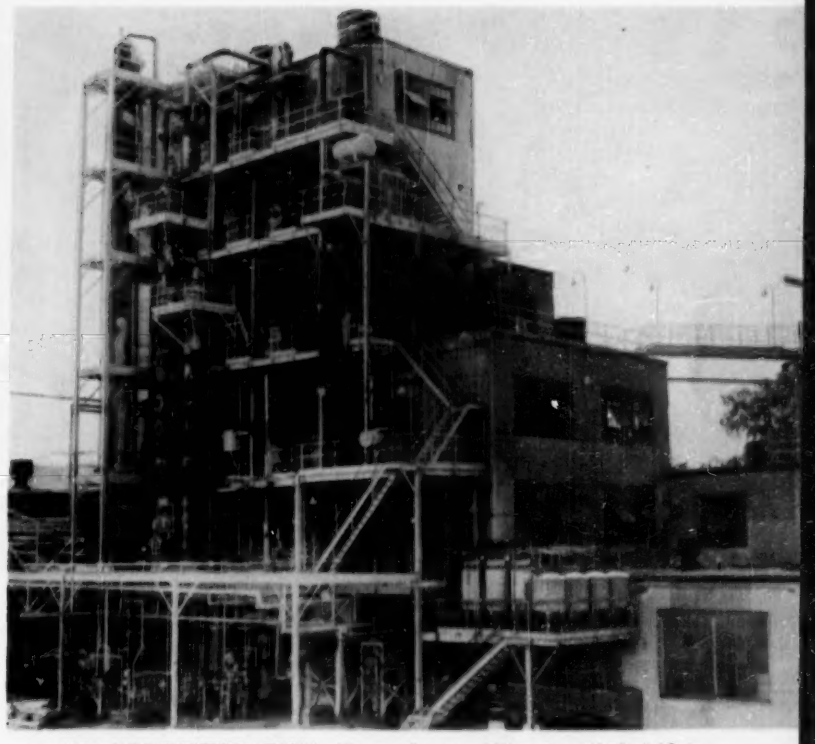


in a glass-lined, 500-gal. agitated steel equilibration reactor equipped with a steam jacket. Sulfuric acid, as catalyst, is introduced and reactor is heated to 100-200 C. and held there for several hr. From equilibration, stream goes to another Na_2CO_3 neutralization stage and then is filtered.

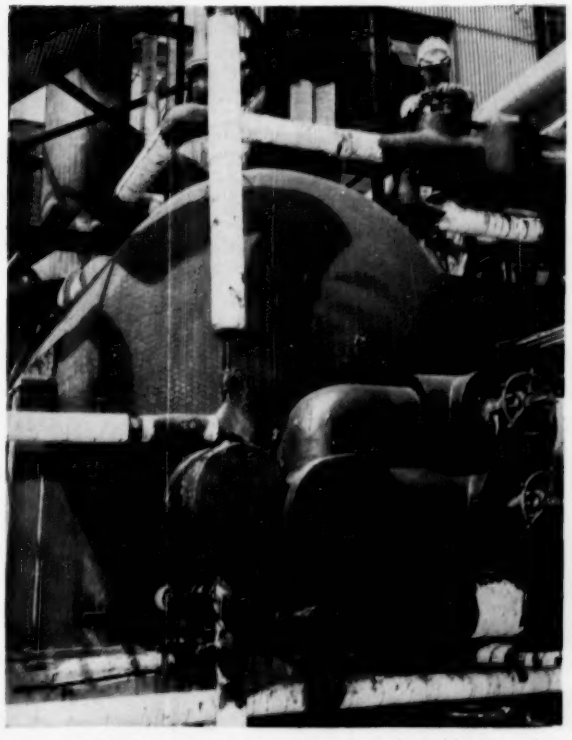
For certain silcone oils a batch still stage is included. It serves to devolatilize the oil by stripping out light ends. Then oil goes to any number of finishing stages where it's formulated into lubricants, defoamers, polishes, cosmetic additives and waterproofing materials for marketing.



1 REACTOR: Silicon and methyl chloride vapor contact over copper catalyst to produce methylchlorosilanes.



3 SILANES DISTILLATION: Four columns split out methyltrichloro-, dimethyldichloro-, trimethylchlorosilane—building links of silicones.



2 BATCH STILL: Any unreacted methyl chloride splits from methylchlorosilanes, then is recycled to reactor.

4 HYDROLYSIS runs continuously in pump, hooks silane into polymer.

5 EQUILIBRATION limits silicone chain length.

THE MEANING OF FLEXITALLIC BLUE

In every field of high-pressure seal—for pipe flanges, pressure vessels, and process equipment—engineers know and recognize Flexitallic Spiral-Wound Gaskets. The blue dye in the Canadian asbestos filler provides positive product identification.

Flexitallic Blue tells the user that the gasket is made by an engineering organization devoted exclusively to the manufacture of Spiral-Wound Gaskets since 1912.

Flexitallic Blue is your assurance that the compression response of the gasket is directly related to the bolting for each application.

Flexitallic Blue is a pledge that manufactured gaskets always conform to specification.

When you see Flexitallic Blue, you can be sure it's a genuine Flexitallic Spiral-Wound Gasket.

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Crane valves cut costs on corrosive services at Crosby

Xylene with dilute hydrochloric acid is routine for these valves

This case history may point the way to reducing valve repairs and replacements in your own plant.

At the Picayune, Miss., plant of Crosby Chemicals, Inc., these Crane 18-8 SMo stainless steel plug gate valves are already in their second year on highly corrosive xylene and dilute hydrochloric acid solution. Valve operation is 6 or 8 times a day. Despite the extremely corrosive fluid these 2-inch No. 18851 Crane valves are handling, there has been no deterioration in their performance.

Here are some reasons why these valves are so trouble-free: Crane plug gate valves have seats cast integral and precision machined to match the plug disc. Straight-through ports permit unrestricted flow; yet, the plug disc construction permits control throttling. Features like these make Crane plug gate valves ideal for many corrosive services—low cost to maintain, dependable for steady production.

Quality performance is routine with Crane valves, because quality methods are routine in their production.

Ask your Crane Representative for a copy of folder AD-2080, describing Crane stainless steel valves.

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THE Raymond combination of *flash drying* and *fine grinding* in a single unit of equipment offers new speed and economy in the production of high grade chemicals, phosphate materials, pigments, clays, synthetic resins, filter cake and many manufactured products.

The rapid flow of finely divided and widely dispersed particles through a steady stream of heated air makes moisture removal almost instantaneous. The system is clean, dustless and automatic. The close control over fineness, dryness and temperature conditions assures a fine, dry, free-flowing finished material

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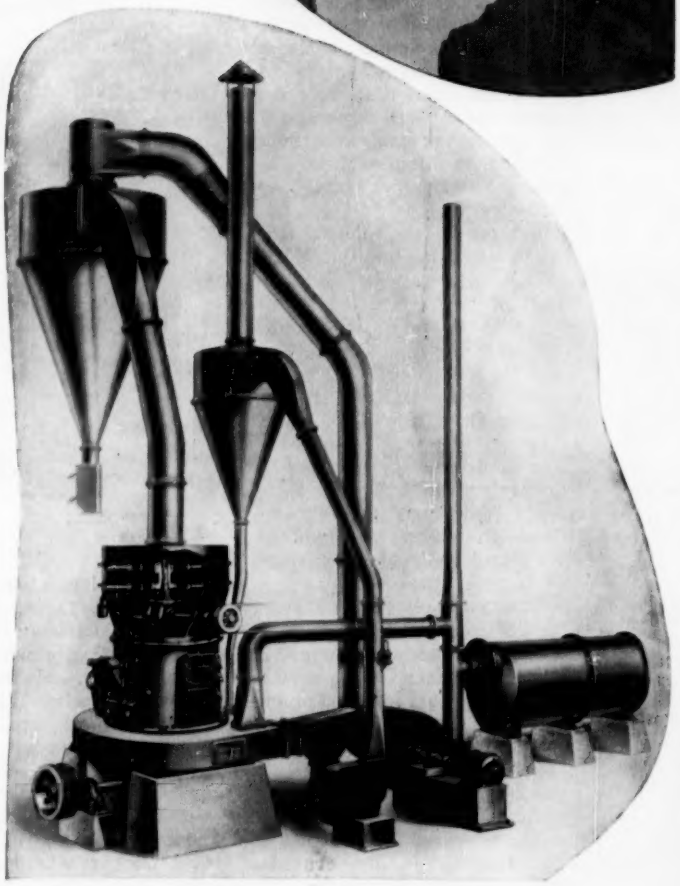
• Pneumatic feed devices maintain a maximum "load" on the mill under all conditions . . . a major factor in Raymond sustained high mill capacities.

• Throw-out attachments reject ungrindable impurities, insuring the delivery of uniform quality products.

• Integral whizzer separators give instant fineness control by one simple adjustment.

Whatever your pulverizing problem, be sure to cheeck with us about this low-cost Raymond method of production.



RAYMOND Roller Mill with Flash Drying Accessories. Write for information on the Raymond Imp Mill and Cage Mill for drying-pulverizing and drying-distintegrating applications.

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Chemical Engineering

Practice

GE's process yields many silicones .... TURN BACK TO P. **228**

Behind the manufacture of nearly 450 silicone products stands a single, uncannily versatile flowsheet.

What to do about a water shortage **237**

If your plant faced an emergency water shortage, how would you cope with it? Here are 8 practical ideas.

New data verify linear equation **253**

For Reynolds numbers in the millions, you can calculate friction factor for fluid flow through pipelines.

Ion exchange: How does it measure up? **255**

Compared with other operations, just what can it do, how well can it do it, and how much does it cost?

How to determine latent heat **261**

These methods will help you estimate the heat of vaporization, of sublimation, and of fusion.

On flow through packings and beds **267**

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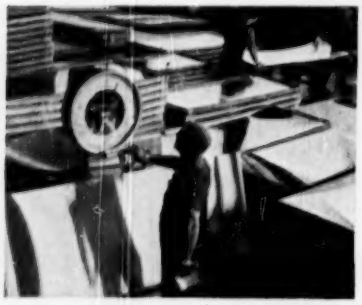

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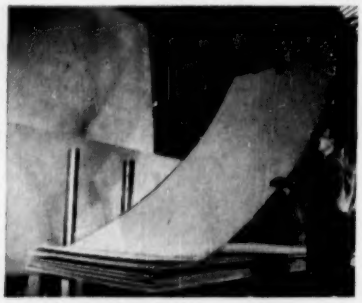

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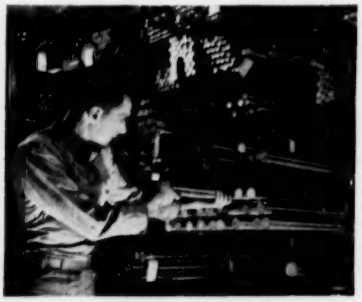

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Chemical Engineering

DECEMBER 1957

How to Cope With a Water Shortage

An imaginary plant faces severe water curtailment. Six experts tell how the situation could be met.

Reported by R. E. CANNON, Natural Gasoline Assn. of America *

IF YOUR water supply source were to notify you that drought conditions made it necessary to cut your water supply 40% within 30 days, what would you do? A panel of industrial water experts at the Industrial Session of the 39th Texas Water and Sewage Works Association's Short School put themselves in this position at Texas A & M College last March. Their suggested solutions were recorded, along with the most pertinent comment from the floor, and the gist reported here.

Hypothetical Stardust Chemical Co. operates a sizeable petroleum refinery and petrochemical plant on the Texas Gulf Coast. Its daily water use is 8,000,000 gal., all purchased from the nearby city of Westfield. The authorities order the plant to reduce its needs by 40% or 3,200,000 gal./day within 30 days, or else make up the difference from other sources.

Although this case is hypothetical, the problem is a very real one that has faced many actual plants in recent years; as water needs continue to increase along with diminishing supplies, it will become still more prevalent in the future.

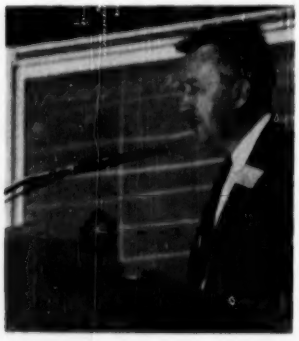
Basic data on Stardust and its water requirements were given to the panel in advance (see box, page 239), who studied a variety of solutions and prepared for a mock meeting of the company's management and engineering personnel. Representing the hypothetical management were J. F. Conlon, chairman and moderator of the meeting, who took the part of the plant manager; and L. L. Hedgepeth who summarized and evaluated the

* This Report was recorded for Mr. Cannon while he was Southwestern Editor of *Petroleum Processing* and before he became secretary of NGAA. Meet your reporter on page 330, and the panel members on page 240.

panelists' proposals, assuming the role of top company management.

Acting as the Stardust engineering personnel were the six panelists, who advanced eight principal solutions. T. L. Satterwhite (Technical Service Div., Humble Oil & Refining Co.) analyzed the types of water losses common to all processing plants, and made concrete proposals for reducing them. D. C. Lee (Celanese Corp.) proposed reuse of plant water together with pollution reduction. A. D. Rust (Dow Chemical Co.) discussed the once-through use of seawater for plant cooling.

J. W. Eberman (Shell Chemical Corp.) suggested supplementing present supplies with ground water. R. E. Morris (City of Dallas) went into the legal and engineering problems met in obtaining water from another watershed. Finally W. E. Gibson (Cosden Petroleum Corp.), from firsthand experience in arid West Texas, presented solutions based on Cosden's use of municipal sewage effluent, plus air-cooled heat exchangers.



J. F. CONLON:

Moderator Describes The Problem

THIS PROGRAM is an experiment in workshop technique in which our panel takes a real but hypothetical problem and brings in some practical solutions based on the other fellow's experience. You will note from the conditions set up (see box, next page) that the Stardust plant is situated on a tidal estuary somewhere in Texas. The map is a mixture of the Pensacola and Mobile Bay areas, to provide two watersheds. The information the speakers will give is illustrative of principles only, but is applicable to our problem case, and indicative of approaches that may apply to your own water shortage, if you have one.

T. L. SATTERWHITE:

Conserve Water by Reducing Losses

Summary—By a planned program of water conservation, we can reduce our water losses caused by waste, inefficient operation, and equipment obsolescence. This program will require cooperation and education to save water in operations. The total investment will be $82,290; annual operating costs, $12,101. Total water saved will be 1,600,000 gal./day—50% of our needs—at a cost of 2.07 cents/1,000 gal. of water saved. This program will be directed at those items of loss common to many plants. In addition, we will explore another possibility—reduction in reservoir seepage—that could result in appreciable savings, but at a fairly high cost.

TO REDUCE the loss of water in any plant, it is essential to have a water balance and a knowledge of the distribution system—to know where the water goes, to what use it is put, the possibilities of recovering that water, or of reducing consumption.

There is a salt water barrier in Grand River just above Westfield that prevents movement of tidal water to the pump suction. Both the City of Westfield and our plant take water from this source. A 15-mile pipeline from the intake to our plant delivers water to a 10-acre impounding reservoir of 16- to 17,000,000 gal. capacity. That reservoir acts as a surge pond ahead of the water treating plant— primarily a coagulation plant.

This treated water is used in all services except boiler feed—which has its own separate treating plant. Total treating plant effluent is piped to the cooling tower. This pipeline continues into a distribution system that supplies treated river water for plant needs. Raw surface water is piped from the impounding basin through a separate line to the boiler house for treatment there.

We have accurate meters on the supply—and on these we base our purchases. Unfortunately, other meters throughout the plant are neither numerous nor well maintained. But, it is necessary to determine consumption, consistent with our knowledge of operations. Table I (lefthand portion) shows the breakdown of our water intake of 8,000,000 gal./day, based on typical petrochemical-refinery operations.

Preparation of a water balance emphasizes the need for maintaining a good set of drawings on a plant's water distribution system. Meters may or may not be justified, but they are most helpful in a water conservation program. We have considered effecting recoveries wherever possible and justified. We have *not* worked out the economics on the basis of yielding a pay-out on the present cost of water. Our water costs 6 cents/1,000 gal.; distribution and other costs run the water up to about 7.25 cents/1,000 gal.

The conservation of water in our plant has been neglected, not because savings are not justified, but because we have concentrated on projects that promise much greater dollar returns than is possible from the recovery of water. Some of the water savings projects we shall discuss will show returns in the order of 200-300% per year, but the dollar savings are small. However, the immediate problem is a matter of obtaining water to continue operation of the plant, and we are proposing to do things that we might best have done years ago for water conservation.

The savings analysis in the right-hand portion of Table I is not consistent with normal procedures for working economics, which usually indicate percent return on investment. But here we are forced to cope with the problem of an impending water shortage, and these are

Basic Data for Problem

The Stardust Chemical Co. consists of two principal divisions: a petroleum division with a refinery of 40,000 bpd. crude charge capacity; and a chemicals division to produce organic chemicals from by-product gases of the refinery as well as from raw materials from natural gas fields. Total complement of the two divisions numbers 2,700 employees.

Both the plant and the City of Westfield get their water supply from the Grand River (see map) upstream of a salt water barrier near the city. Present water consumption of the plant is 8,000,000 gal./day; of the city, 2,000,000 gal./day. The water has a pH of 7.7; its quality is represented by the following typical analysis:

	Parts per million
Chlorides	150 ± 50
Total alkali	115 ± 10
Total hardness	200 ± 20
Calcium (as $CaCO_3$)	150 ± 15
Magnesium (as $CaCO_3$)	45 ± 15
Silica	9 ± 3
Sulfate	65 ± 15
Turbidity	80 ± 25
Total dissolved solids	400 ± 125

Utilities

1. Steam plant—capacity 1,000,000 lb. per hour; maximum pressure 600 psig., which is reduced to supply steam at 200 and 75 psig. Condensate return, 50%.

2. Fuel gas (natural gas supply)—20 cents per million Btu.

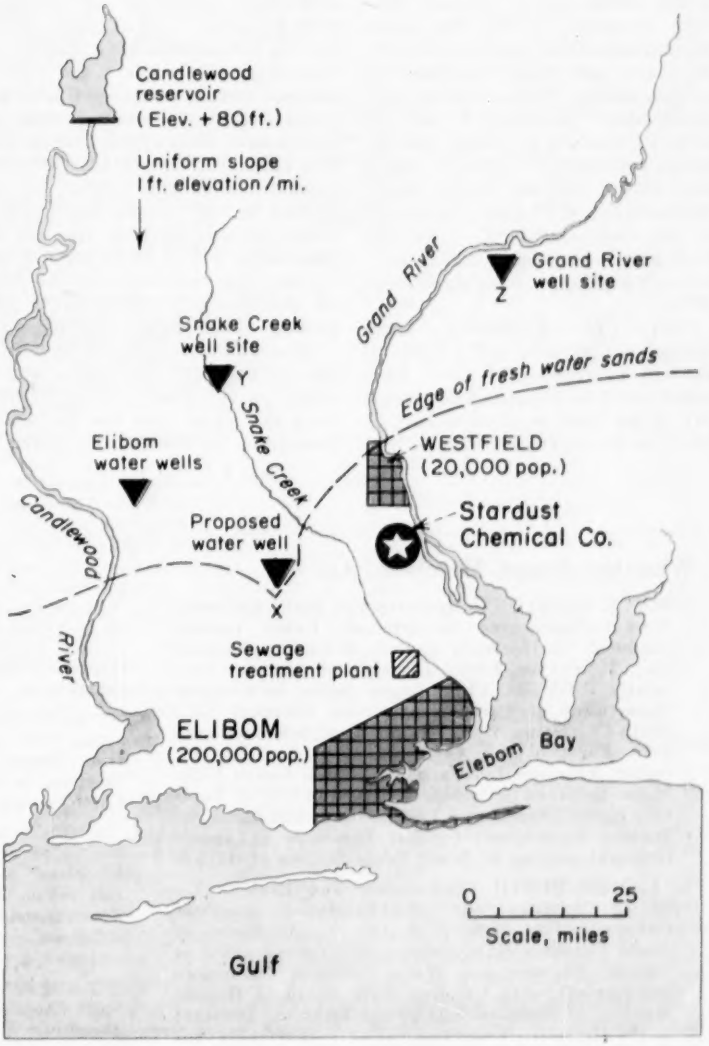
3. Water conservation — amount of water to be conserved is 3,200,000 gal./day.

3. Saline water — is available with a chloride concentration of 4,000 ppm. up to the salt water barrier at Westfield. The maximum temperature of the salt water is 85 F. Its minimum temperature is 55 F.

Miscellaneous Data

1. Rainfall (annual)—27 in.

2. Runoff—3 in.



3. Net reservoir evaporation—35 in.

4. The City of Elibom has a modern sewage treatment plant with effuent of high quality.

5. The City of Westfield was incorporated several years ago and is now required to build a treatment plant.

6. Candlewood Reservoir is a newly developed project in a watershed separate from that of the Grand River. The reservoir is approximately 80 miles from the plant of the Stardust Chemical Co.

7. The water supply of Elibom is from nearby wells.

8. New water well near Snake Creek gives water of marginal quality.

things that can be done in the 30 days we have been given to reduce our water intake by 40%.

Items (3) and (11) in the savings column are the reduction of domestic consumption and of losses from wash hoses. Proper education of our people and a planned publicity program within the plant will emphasize the need for conserving water and make possible the savings shown. With a well planned conservation program, it will be perfectly feasible to reduce the domestic consumption by 40%, from 50 to 30 gal./day per capita, effecting a savings of 28 gpm.; there will be no costs involved. Likewise, wash hose losses can be cut by 80% through a planned program of education.

Item (4*a*)—Equivalent once-through water use at the light oil treaters averages 200 gpm. This water could be reused at the treaters if we were to discard half to minimize concentration of dissolved solids and contaminants. Therefore, at the cost of a surge tank for $1,000, a pump for $600, and 100 ft. of 4-in. pipe at an estimated $800—a total investment of $2,400—we can effect a saving of 100 gpm.

Item (4*b*)—Water from the Hydroformer scrubbers is charged with SO_2 and its pH averages about 3.2. In the past we have considered recovering this water in the cooling system. Before we had artificial pH adjustment in the cooling tower, it would have been prohibitive to use this acidic water. We now propose, however, that this water be returned to the cooling tower. The debits associated with the use of this water will be $6.50 per day because of the reduction (by the SO_2) of chlorine and chromate in the cooling tower water treatment.

Item (5)—We propose to gather the water from six pumps into a sump, provide a small pump, and return the water into the hot water line going to the cooling tower.

Item (6)—Original circulation of this water over the cooling tower was discontinued because intermittent acid leaks prevent the accurate pH control necessary with our present water treatment. We propose that a separate cooling tower be installed to serve the acid plant. This cooling tower should be a 500 gpm. unit with a cooling range of 100 to 95 F.—a little warm because the tower we are considering is not really efficient enough to reduce the water temperature to the 5-7° approach to the summertime wet-bulb temperature that is possible in the large tower. The proposed new tower is to be constructed of concrete or masonry walls and packed with ceramic Berl saddles. It will have an induced draft fan.

Item (7)—Inspection of the return line from the pipe still bottoms box shows a flow-restricting scale deposit that is largely a deposit of calcium carbonate. Contamination

Who the Panel Members Are

JOHN F. CONLON (Moderator) — Staff Engineer, Works Engineering Department, Union Carbide Chemical Co. (formerly Carbide & Carbon Chemical Co.), Texas City, Texas. Graduate of Columbia University, 1933, BS, ChE. Began career in Research Department of Carbide & Carbon Chemical Co.'s South Charleston, West Virginia plant, remained until 1950. For two years (1950-1952) was Technical Director, Acumeter Laboratories, Newton Lower Falls, Mass. Returned to Carbide & Carbon in 1952 at Texas City plant. Chairman of Texas Sewage and Industrial Wastes Association; General Chairman of annual technical meeting of South Texas Section of AIChE.

L. L. HEDGEPETH (Summarizer and Evaluator)—Senior Consultant on Water Sanitation, American Cyanamid Co., New York, N. Y. Graduate of North Carolina State College, 1925. Four years as District Engineer and Water Pollution Laboratory Director of North Carolina State Board of Health; Manager of Technical Service and Technical Assistant to the Executive Vice-President of Pennsylvania Salt Manufacturing Co. for 17 years; Executive Secretary of Virginia Water Pollution Control Board for two years; joined American Cyanamid over eight years ago. Member and past chairman of the Manufacturing Chemists Association's Water Pollution Abatement Committee; Co-chairman of American Water Works Association; past member of Board of Control, Federation of Sewage and Industrial Wastes Associations.

T. L. SATTERWHITE—Staff Engineer, Utility Section of Technical Service Division, Humble Oil & Refining Co., Baytown, Texas. Attended University of Texas. Member of ASME Power Test Codes Committee, Subcommittee on Atmospheric Cooling Equipment. Participated in organization of the Cooling Tower Institute. In Texas Water and Sewage Works Association, he is a member of the following committees: Water Works Operator's Certification Committee, Committee on Reorganization, Committee on Water Resources.

D. C. LEE—Assistant to the Plant Manager, The Celanese Corp. of America, Bishop, Texas. Graduated from Texas University in 1948, BS, ChE. Joined Celanese in 1948 as a process engineer, becoming Chief Process Engineer in 1953.

A. D. RUST—Engineering Consultant, the Dow Chemical Co., Freeport, Texas. Graduate of University of Maryland, registered Professional Engineer in Ohio and Texas. Joined Dow during beginning stages of Texas Division in 1941. Author of numerous papers on industrial power, use of sea water in industry, and corrosion problems.

J. W. EBERMAN—Manager of Utilities Department, Shell Chemical Corp., Houston, Texas. Has been engaged in design, construction, and operation of industrial power facilities since 1928. He joined Shell Chemical in 1943.

R. E. MORRIS—Assistant Superintendent of Dallas (Tex.) Water Works. Graduated from Texas A & M College in 1931, BS in Civil Engineering. Has been with the City of Dallas Water Works for 21 years, beginning as a junior engineer, later becoming Chief Engineer. Assumed present position in 1955.

W. E. GIBSON—Utilities Engineer, Cosden Petroleum Corp., Big Spring, Texas. BS, ME from University of Texas in 1944. Joined Phillips Chemical Co. as a design engineer in 1946; later became Maintenance Engineer and Process Coordinator. Became associated with Cosden in 1951, beginning as a project engineer.

Water Balance and Water Conservation Summary for Stardust Chemical Co.—Table I

Water Use	Explanation and Remarks	Quantity Now Used, Gpm.	Quantity Saved, Gpm.	Invest. Req., M $	Oper. Cost,* M$/Yr.	Cost of Water Saved, C./M Gal.
1. Cooling tower	One centrally located tower. Quantity calculated from evaporation loss from tower heat balance, plus blowdown calculated from water concentration	2,350	.....	.....	.....	....
2. Boiler feed	Steam produced, 1,000,000 lb./hr. Makeup calculated from water concentration.	1,390	.....	.....	.....	....
3. Domestic consumption	Est. at 50 gpd./employee.	70	28	.....	.....	....
4. Process	Does not include loss of steam condensate. Breaks down into 200 gpm. for wash after caustic treating in light oil treaters; 160 gpm. for Hydroformer scrubbers; 60 gpm. for quenching after catalyst regeneration wash; 10 gpm. for chemical blending.	430	100(a) (Light oil treaters)	2.4	0.365	0.70
			160(b) (Hydroformer scrubber)	6.2	2.995	3.56
5. Pump glands	Total loss from pumps not equipped to recover gland cooling water.	30	30	1.04	0.116	0.74
6. Acid plant	Leaks from acid cooler coils. This water originally returned to cooling tower before low pH water treatment. Now discarded to sewer.	430	425	16.9	2.650	1.17
7. Pipe still bottoms box	Open bottoms cooling box. Loss results from internally scaled return line which slows outflow, causes overflow to sewer.	50	50	0.75	0.375	1.43
8. Clay slurry	Water used to pump spent clay from lube oil treating area to disposal pit.	50	.....	.....	.....	....
9. Reservoir	Losses result from: evaporation, 18 gpm.; seepage, 133 gpm., calculated from gradient of water table as determined by borings (Empirical data for this type soil indicate only 23 gpm.); transpirational losses from 450 x 200-ft. section of heavy growth, 6 gpm.	157	.....	.....	.....	....
10. Line losses	From leak-loss survey of plant lines. Most of this loss is in 2,600 ft. of 20-in. line.	280	275	56.0	5.600	3.90
11 Wash hoses	Estimated loss from indiscriminate use.	30	24	.....	.....	....
12. Unaccounted for	Difference between known and estimated losses, and metered intake.	283	.....	.....	.....	....
Total gpm.		5,550	1,092	82.29	12.101	2.07 avg.

*Operating costs include depreciation, operating labor, power at 1.7 c./kwh., and overhead.

is from leaking coils, and the carbonate, along with oil and sediment, has built up about ¾ in. thick inside the line. Reduction in cross-sectional area does not contribute to the increase in pressure drop nearly so much as the reduction of friction factor from roughness of the pipe.

There is a differential head of 8 ft. between the overflow in this box and the point of recovery. The calculated loss at a flow of 800 gpm. through the 200 ft. of 8-in. line is 4 ft. The measured pressure drop for the actual flow of 750 gpm. is 8 ft., indicating a C factor of 65 (Williams and Hazen formula), compared to 130 for new steel pipe and 100 for design calculations.

This line has a number of bends and we cannot clean it with our own forces. However, for an estimated $750, we can contract this work to a specialty firm that guarantees a resulting C factor of 100.

Item (9)—There are a number of possibilities for reducing seepage losses from our reservoir but because of high costs, we are not recommending treatment. Butyl rubber sheeting is quoted at a price of $1.08/sq. yd., plus 10 cents/sq. yd. installation, or $61,000 for our 10-acre pond. Another method we could consider is the use of portland cement at about $1.80/sq. yd. applied, or an investment of $93,500.

Asphalt might be the cheapest method to reduce seepage losses. At an installed cost of about $1.50/sq. yd., and with an estimated effective life of 5 years, we have a total investment of $78,000 for lining the pond, or a cost of $15,600 per year. Assuming a saving of 100% of the seepage, which is equivalent to 57,750,000 gal. per year, we calculate a cost of 27 cents/1,000 gal. of water saved. This is quite a high price for water, but the cost may be justified if we must have it.

Item (10)—The 20-in. line from the treating plant to the cooling tower carries all makeup water for the cooling tower, so it cannot be removed from service for repairs—even for a short period.

We propose to replace this line with a new line above ground to avoid the excessive corrosion of

underground lines and the problems of detecting leaks. Depreciating that line over 10 years, at an annual cost of $5,600, we can produce savings costing 3.9 cents/1,000 gal.

Walter A. Quebedeaux (Harris County, Texas, Stream and Air Pollution Control Section): Would it be possible to mix some of the acid water from the scrubbers with the bottoms-box water to keep incrustations from forming?

Satterwhite: We haven't checked that possibility. You are talking about a pH controlled water, so if we can introduce the proper amounts of acidic water to stay out of the corrosive range, that would be an attractive consideration if we could justify the expense. This water from the scrubbers is extremely corrosive and it will take an expensive pipe.

Quebedeaux: At moderate temperatures you can use plastic pipe.

Comment: Wouldn't you get calcium sulfite or sulfate sludging just as well with calcium carbonate if you use the acidic water?

Quebedeaux: You will get a slurry of calcium sulfate, but it will be fine enough to go on through with your flush. I'm assuming that you don't have too much incrustation at that point.

Dr. Louis Koenig (Research Consultant): In Table I, the investment cost figure of $82,290 is about 6 cents/gal./day of capacity —not a very high figure as water investment costs go. Average investment costs in a municipal water system are about 50 cents/gal./day of capability, including the distribution system. The average municipal or industrial well—just the well—costs about 16 cents.

I would judge, then, that you might be able to make a few changes which have higher investment costs.

Studies by the Bureau of Reclamation on canal linings have indicated that the cost of the non-reinforced concrete lining they now recommend is about $1.30 to $1.80/sq. yd., which is roughly comparable with the cost of your asphalt lining. The Bureau of Reclamation indicates that asphalt linings on ditches (where the service is probably more severe than in a reservoir) will last 8 to 10 years, whereas they have every indication that a concrete lining will last 40 years. In fact, there are some 60-year old linings in operation.

You had an operating cost for saving seepage from the reservoir of 27 cents/1,000 gal., which you threw out as being too expensive. You got that by applying a 5-year life to the asphalt. I don't know the depreciation policies of the company, but if you use a concrete lining and could take a 40-year life, as is customary in water-works practice, you would reduce that 27 cents to about 3½ cents/1,000 gal. So maybe you could consider somewhat higher investment costs and possibly bring back into the picture the saving of this rather large seepage loss.

D. C. LEE:

Reuse Plant Water and Abate Pollution

Summary — By changing our present method of cooling water treatment, we can cut our water consumption by 400 gpm., or 600,000 gal./day. This saving requires no capital and the revised treating method can be put into operation at once.

We can realize other water savings in two specific cases: 100 gpm. by reducing steam injection to one of our columns; 100 gpm. by using cooling tower blowdown for scrubbing air to the oxygen plant. These two measures will require a capital investment of $60,000.

In addition, we will point out several other places in the plant where we can save water, but we are not prepared to make recommendations without further study.

OUR SUBJECT can be broken down into three broad areas: cooling tower operation, reuse of process water, and pollution abatement.

The most important consideration in saving water is cooling tower operation, because that is where the average plant uses the most water. Much of our information on proper methods of cooling water treatment is based on work done by the recirculating cooling water subcommittee of the National Association of Corrosion Engineers.

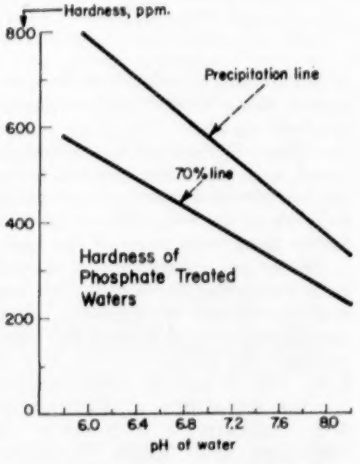
There are several objectives of cooling water treatment:

1. To prevent scaling of cooling surfaces, either by external treatment (softening or ion exchange), or by keeping the precipitant materials, usually calcium and magnesium salts, in solution (normally by sulfuric acid treatment). Either method requires a cooling water blowdown to prevent total dissolved solids or hardness from exceeding the desired level.

2. To prevent corrosion, usually accomplished through control of total dissolved solids, the addition of inhibitors and control of pH.

The remaining objectives of cooling water treatment, those of preventing fouling of cooling surfaces by algae or slimes, the prevention of sludge buildup, and the prevention of wood deterioration, are not involved in water saving.

Cooling Tower Operation—Our present method of cooling water treatment is called dianodic protection, a combination polyphosphate-chromate treatment. Treating chemicals are used in concentrations of 40 ppm. phosphate and 20 ppm. chromate. The amount of cooling tower blowdown is a function of the hardness of the water.



As the graph shows, the limiting hardness concentration is based on the precipitation of calcium or mag-

nesium phosphate sludge on the cooling surfaces, with the solubilities increasing with lower values of pH. We are running at a pH of 6.0—about as low as we can safely go from a corrosion standpoint. At this point on the graph, and using the 70% operating line for safety purposes, a maximum hardness of 550 ppm. in the circulating cooling water is indicated, and this is the hardness level we are now holding in the system.

In our makeup water our total hardness is 200 ppm., plus or minus 20 parts. From this we calculate the concentration ratio, the amount of blowdown required, and the amount of fresh makeup required. In this case, 550 ppm. allowable divided by the 220 maximum—the hardness of the water—gives us a concentration ratio of 2.5 times.

The concentration ratio then allows us to calculate the required cooling tower makeup. Under our present operating conditions this comes to a total of 3,380,000 gal./day makeup, including evaporation, or 2,350 gpm.

Can we decrease the use of cooling water? We have to look first at our present method of operation, combined with our present treating method. Since we think we are doing the best we can in maintaining the maximum safe concentration ratio, we believe that the present method cannot give us a saving of water by any operation changes.

Therefore, we have considered changing the treating method. There is one method that will work and will give us a substantial decrease in cooling water blowdown. In this method, the amount of phosphate is drastically reduced so the hardness level of the circulated cooling water can be increased without forming phosphate scale. This is the so-called "threshold" phosphate treatment, which maintains metaphosphate at about 3 to 5 ppm. Dichromate is maintained at 100 ppm. to give corrosion protection. Also, pH is raised to about 7.0. This again is a fairly common method of treating water.

Because the phosphate level is much lower, we can raise total hardness to about 900 ppm. before we reach the precipitation level of calcium phosphate. Also, we feel that we can raise the allowable percentage line to about 90% level because of the low phosphate level, i.e., 90% of 900 ppm. is 810 ppm. hardness allowable, instead of the 550 ppm. with the present treating method.

With an 810-ppm. allowable hardness, the allowable concentration ratio is 3.7 and cooling tower makeup drops to 1,950 gpm., a saving of about 400 gpm. No capital expenditure is required. The saving of water can be realized as soon as we can get the new control system detailed.

Reuse of Water—There are no formulas for determining where water can be reused. Instead, each application is likely to be unique, with the final answer depending on many factors such as the quality and quantity of water required, kind of water available, possible corrosion or contamination problems, and cost.

Reuse of water is a problem that we have given attention to in the past because of the large savings that are potentially available. These are not in the cost of the water saved, but lie in the possibility that there are still valuable products in the waste streams that can be recovered.

There is no reason for using fresh water to pump fuller's earth to the disposal ponds and we could use process water from the API oil separator. A small retention pond and a pump are necessary to send the water to the desired point. There are other possible uses for this water which should be investigated further, such as washdown purposes, or in process vessels such as the acid scrubber. However, if we take the water from the acid scrubber and put it in a cooling tower, then we would have no justification for changing the water to the scrubber.

Our first recommendation for reuse of water in the chemical plant involves a distillation column using steam stripping. We give particular attention to any distillation column which is using steam stripping instead of reboilers because the steam adds extra water to the process and usually increases waste water to be disposed of. The column in question uses 50,000 lb./hr. of steam to strip organic chemicals from a crude reaction product. Unfortunately, this product contains high-boiling materials which cause fouling of a reboiler, so we cannot avoid the use of open steam stripping.

There is a waste water stream from another source that is not badly contaminated, and we are proposing to pipe part of the stream to this tower and boil it in a kettle reboiler, thus generating steam which can be injected into the tower for stripping steam. In effect, we continue injecting live steam but we have reduced a waste stream by 100 gpm. and have increased condensate return to the boiler by 100 gpm.

Unfortunately, this is a corrosive service which will probably cost about $50,000 for a stainless steel installation. We feel that there may be a good payout based on additional product recovery from the waste stream.

We have an oxygen-producing unit in the chemical plant where we have to be very careful to prevent oils from getting into the system because of the danger of explosion. Therefore, the compressed inlet air to the unit is scrubbed with water to knock out any oil which might be present from the compressors. This water does not have to be too pure in itself, so long as there are no volatile materials in it. Hence, we propose to switch over to the use of cooling tower blowdown for makeup to the scrubber. This reuse of water should reduce our consumption by another 100 gpm.

Pollution Reduction—Such reduction is associated with water reuse to this extent: first, reuse of water often gives an equal reduction in waste water; second, in times of drought, when water is scarce, there is less dilution by river water and the river pollution problem is increased.

Several approaches appear suitable for our waste water. However, in this area of fairly high net evaporation, we propose to get rid of waste by solar evaporation. Net average evaporation in this area is 35 in. per year over and above rainfall. This is a long term average but must be taken with some degree of caution. The data are from the Texas Agricultural Experimental Station Bulletin 484. However, the data in that bulletin cannot be considered precise because there are various testing methods by which the data were arrived at, and some of them perhaps cover too short a period of time to be of statistical value.

In sizing the ponds, there are factors to consider other than average evaporation. For instance, what are the chances that some years, or series of years, would have rainfall above average so that we could not

get the required evaporation? We have made statistical studies of these data and have arrived at some probability factors which say that, on a 50% assurance basis, not more than once in a hundred years would the net evaporation be zero for the year. On a 95% basis, this would not occur more than five times in a hundred years. We also looked at combinations of years to decide how deep we would have to make our ponds to absorb these increases in level when we are getting low evaporation rates. The answer given by this statistical approach is that the dikes for the ponds should be 5 ft. high. Cost of such evaporation ponds would be in the neighborhood of $1,000 per acre.

The evaporation rate that I quoted will allow about 1.8 gpm. of effluent per acre to be disposed of. If we take the total of all of our waste waters after the improvements we are proposing—but not including our cooling tower and boiler blowdown, which are not contaminated and will continue to discharge to the river—we will have approximately 600 gpm. to dispose of by evaporation. The calculated area would, therefore, be 334 acres. The capital cost is estimated to be ¼ to ½ the cost of trickling filters or superactivated sludge plants, based on our BOD requirements of about 60,000 lb. per day. The operating cost for the evaporating ponds is obviously much less than for other methods of treatment.

Quebedeaux: Have you considered the toxicity of chromates that would be discharged directly into the stream? Chromates are pretty toxic to marine fauna, diatomes, and algae, even in very dilute concentrations.

Lee: We are proposing to switch to chromate with threshold phosphate and we feel that it will not be harmful to marine life. We have looked at its effect on marine life only because it discharges into a tidal estuary where the water is saline to begin with.

Quebedeaux: You might consider going to a detergent rather than a phosphate. There are several non-ionic detergents that keep your phosphates in solution and they are required in such small quantities that, when you use them, you do not get any appreciable effect on either your BOD or any pollution characteristics of the stream that contains them.

John Wold (Shell Chemical Corp.): If you have 2½ cycles of concentration and are using 2,300 gpm, your evaporation load on the cooling tower is probably around 1,500 gpm. So the blowdown, under present uses, may be upwards of 900 gpm., yet the total solids in the raw water is upwards of 400 ppm. You could possibly go up to 10 or 12 cycles of concentration if you used a sodium-treated water. Was that considered? In other words, sodium zeolite treatment of, say only 1,500 gpm., then go to 10 cycles of concentration with a little pH control.

Lee: The chloride content of the water would prevent any such concentration ratio. The concentration of chlorides that will result from the proposed concentration of 3.7 is felt to be the maximum allowable because of the possibility of chloride-induced stress corrosion in stainless steel exchangers. Also, such a system would probably require much longer than 30 days to get in.

A. D. RUST:
Use Once-Through Salt-Water Cooling

Summary—Converting our cooling water system to the once-through use of seawater is not an emergency solution to our problem, but could be a very good solution to the long-range problem. It is entirely practical, though relatively expensive.

Capital outlay would be about $940,000, and the cost of a plentiful supply of water would be 3.7 cents/1,000 gal.

LET'S CONSIDER seawater or, as we have shown it here, tidal water with a chlorides content of 4,000-5,000 ppm. The chlorides content is going to swing from 100% fresh water to 100% seawater, and everything in between. 100% seawater is about 35,000 ppm. total solids, or some 33,000 ppm. chlorides.

I propose to build an intake in the estuary (see map) far enough from shore to assure a reliable depth of submergence, and deliver the water into a reservoir near the shore. The reservoir would act as a sedimentation basin for periods when the river is muddy, and as a reserve when an intake pump fails. Clear water can be taken out of the far side of the pond, screened, and pumped into the plant.

The intake structure would be a creosoted piling. I have calculated it on the basis of there being 1,000 ft. from the intake pump to the reservoir, and for a capacity of 10,000 gpm. This 10,000 gpm. can be used for cooling in the plant as conditions permit changes in specifications. It is possible that some existing specifications may permit the use of seawater. The best advantage from using seawater would come from picking a place which has the greatest heat load, and changing specifications of that item; then the next greatest, and so on—on the premise that the use of seawater is not an emergency substitute, but is something permanent.

A vertical submerged pump will be mounted on creosoted pile bents. We are talking about one 10,000-gpm. pump with sufficient head to deliver into a reservoir 40 ft. above mean low tide. This pump will be of the mixed-flow type, with specifications for seawater use. Such equipment is practically as permanent as equipment designed for fresh water. The cost of the pump without motor would be very close to twice the cost of an ordinary bronze-fitted pump. If you used a cheaper specification for a seawater pump, it would not be economical.

My figures are based on the use of a 30-in. line from the intake pump to the reservoir and a 30-in. line from the pumps at the reservoir to the plant. I have used a length of 1,000 ft., and a rate of 10,000 gpm. delivered into the plant at a head of 150 ft.

Coal-tar-enamel lined pipe is frequently used in larger pipeline sizes. One big advantage of such a

lining is the improvement of the *C* factor. We usually use a *C* factor of 100, but in large lines you can safely use 140. If it is 140 today, you can expect it to be 140 five years from now.

The settling basin should be designed so that there is a narrow strip along one levee where rapid sedimentation of heavy particles will take place. We will use such a trough for preliminary sedimentation and force the water over a weir at the end of the trough and into the remainder of the reservoir. The reservoir should be sized so velocity is practically nil. Hence, turbidity in the lines going to the plant should be very low. When the river is low enough so there is no flow past the barrier, there should be no turbidity at all.

The screen used for this work is a rotary, with a 6-mesh screen, costing about $10,000. This is much cheaper than the roller-towel type screen, but it takes up considerably more area.

The estimated capital outlay would be $940,000. The cost of water delivered to the plant, assuming it is within 1,000 ft. of the reservoir, would be 3.7 cents/1,000 gal. Dimensions of the reservoir could be reduced, but the 3.7 cents wouldn't change materially. This cost figure also includes pump power, maintenance, and operation.

In using seawater, we should bear in mind that temperatures are important. When using high-chloride waters, corrosion troubles increase at an accelerating rate. We have a rule of thumb that corrosion rates double between 50 and 100 F., but between 100 and 120 F., they'll double again. Over 125 F., specifications have to be revised all over again.

Normally, we may expect a reversal from fresh water to seawater, and from seawater back to fresh water, at least once or twice a year. One result will be that sea life which gathers in the reservoir will die off when fresh water is pumped in. Similarly, fresh water life will die when seawater is introduced.

When using 100% seawater all the time, it is necessary to chlorinate to keep down life that gets past the screens. The recommended chlorination rate is 1 ppm., but that should be gaged by the residual in the effluent. The best practice is to try to maintain a residual of 0.3 ppm. in the effluent. More than that will give pollution troubles, and will also waste chlorine.

One advantage of seawater—other than that it is plentiful and has no cost at the point of origin—is that plants that may have been restrained severely previous to its use can now use barometric condensers. There are lots of them used with straight seawater and they stand up quite well.

Quebedeaux: I'd like to suggest that the use of flocculation agents can quite materially reduce chemical requirements and also reduce the time required for getting mud out of the water.

Gulley (Gulf Oil Corp.): In using tidal estuary water for plant cooling, there would be a problem of fine mud, particularly when the water is fresh. This mud would agglomerate in tube bundles at high temperatures and plug the tubes, causing severe maintenance problems. Another problem would be the location of the discharge, since, during periods of low flow, recirculation might occur, and you wouldn't get the required cooling.

Also, the chlorine you propose to administer would probably influence your corrosion rate adversely.

Rust: What detention time are you considering for the water in the reservoir?

Gulley: In my experience, detention time is of very little value. Trouble will occur when the water freshens up. As long as the water is salty, there is no problem with mud, but when the water freshens up, there will be quite a problem with the very fine colloidal silt that won't settle out. It would require flocculating agents and then the agents themselves would plug up tube bundles if they carried over.

Rust: I'll admit that I would rather deal with straight seawater.

Gulley: In your investment figures, you should take into account some oil separator facilities, because of leaks in the plant. And separators are pretty expensive when you get up to 10,000 to 20,000 gpm. Also, you have the problem of increased piping to get the water out of the plant—sewers and so on.

Rust: That's correct. We'll have to consider specifications throughout the plant at any point where we use seawater and they will be more expensive than where we use fresh water.

Brady (Humble Oil & Refining Co): I want to second the remarks of Mr. Gulley, and also to point out that if you're going to use salt water in the plant, you're going to have to provide a separate sewer system. If that water gets mixed with process water and you have no pH control, you're going to have large quantities of flocculant material formed that will increase the amount of emulsions in the separator and the amount of oil carried through the separator. We have found from experience that it's much better to do away with salt water and use something else.

J. W. EBERMAN:

Find a Supply of Well Water

Summary — A convenient solution to both our emergency and long-range water problems would be to supplement the supply of Grand River water with well water. This would require drilling a well on the upper reaches of that river, capable of producing 2,000 gpm. Thus we could realize a total of 2,880,000 gal./day at a cost of about 3 cents/1,000 gal.

ONE OF THE obvious alternates for surface water is ground water. It's quite a switch to think of seeking ground water to make up a shortage of surface water. In other parts of the country, it's the other way around, which shows how important the geography of a plant can be.

At point *X* on the map, we have a site for a water well. You may wonder why we went 15 miles for a well site—why not build it in the

plant? The answer is disappointing but simple: the dotted line on the map is the edge of the fresh water sands. We can't get fresh water unless we go somewhere fairly well inside that line. South of the line the ground water contains more than 500 ppm. chlorides and 1,000-1,500 ppm. total solids; north of it the water has less than 500 ppm. chlorides and less than 1,000-1,500 ppm. total solids.

Table II supplies basic data for any well we may drill inside the fresh water line. It shows that the water is marginal in quality. However, marginal is a relative term, and depends on what you have and what you're used to.

This is water that, according to Mr. Lee, he could use. With this hardness he might have to increase his blowdown on the cooling system and this might mean we would have to supply more than 2,000 gpm. This water may not be usable in the boilers but certainly we could use it in the cooling system.

In working out the economics of piping this water to the plant, we considered various pipeline sizes to find out what the system would cost on the basis of a pump at the well, plus a booster pump.

Table III shows costs involved in a 15-mile long pipeline and in building and operating a well-head pump, plus one booster pump station. Notice that the pipeline is the major expense — $600,000 to $810,000 — with the optimum being either the 14-in. or 16-in. line. In the likelihood that river conditions will vary and approach normal, we can assume that we will have to operate the well not over half the time—say 180 days/year.

Now, let's consider the possibility of getting rid of this 15-mile line, which, as you see, is a major part of the cost of using water from this well. Also, we can't get a 15-mile line laid in 30 days.

We have to keep inside of the fresh-water boundary, or we are going to get salt. So suppose we put our well at point *Y*. The further inside the line, the better. But by taking a point somewhere around Snake Creek, we could pump our water into the creek and use it for a flume or canal down to a point about 4 miles from Stardust Chemical. That means, at the cost of a dam, we get rid of 11 miles of pipeline and cut our power costs and our capital costs. The cost would be only one-third of that required at the first location. But, I doubt if we can get even 4 miles of pipeline laid in 30 days.

Data for Proposed Well—Table II

	Units Noted
Static level	90 ft.
Drawdown for 2,000 gpm.	180 ft.
Screens	400-800 ft
Estimated cost	$80,000
Power required	187 kw.
Water quality, ppm.	
Hardness, 355	Sulfates, 305
Alkalinity, 220	Silica, 32
Chlorides, 170	TDS, 1,150

Now there is still another alternative that looks better: pick a spot, point *Z*, up on Grand River, drill our well, and use Grand River for our pipeline. We will simply replace the water deficit with our well water and take it as usual by intake into the plant. That has the advantage of needing no pipeline, no dam on Snake Creek, and of having a capital cost which would be essentially the cost of the well itself.

Daily operating costs would come out something like $45 for power—that's just the well power—and about $20 for maintenance. The fixed charges, being 8% on the well cost, come to $18 to $22 a day, or a total of between $83 and $87 a day. Production would be 2,880,000 gal./day, or a little over 3 cents/1,000 gal.

Of course, we are talking about marginal water to begin with—water with 355 ppm. hardness and 1,150 ppm. total solids. Table IV shows the quality of the well and river water, and what would happen when we mixed the two.

Summary of Costs for Well at Point X, With 15-mile Long Pipeline*—Table III

Pipeline Size, In.	Press. Drop, Psi.	Total Capital Costs: Well, M $	Booster Pump, M $	Pipeline, M $	Total, M $	Daily Operating Costs: Kw. Well	Kw. Booster	Daily Power Cost, $ at 0.01	Daily Maint. Cost, $	Annual Operating Costs for 180 Days/Yr.: Power, 180 D., M $	Maint., 365 D., M $	Cap. Cost at 8%, M $	Total, 365 D., M $	Cost per 1,000 Gal., Cents
12	515	80	90	600	770	187	660	202	30	37	11	62	110	23
14	320	80	65	645	785	187	430	147	30	26	11	63	100	21
16	160	80	35	720	835	187	215	97	30	18	11	66	95	20
18	90	80	20	810	910	187	120	75	30	13	11	73	97	20

*Based on pump station at well site, with one booster station. 12-in. pipe with 0.25 wall, others 0.188 wall.

Quality of Well Water-River Water Blend—Table IV

	Well	River	Blend
Hardness	355	180–220	230–260
Alkalinity	220	105–125	140–153
Chlorides	170	130–170	142–170
Sulfates	305	50–80	126–147
Silica	32	6–12	14–18
Turbidity	0	55–105	37–74
Total diss. solids	1,150	500–650	700–800
1,000 gal./d.	2,280	6,800	9,680

The way we propose to do it, we would be pumping about 2,880,000 gal./day into the river and the river flow itself would provide 6,800,000 gal., of which 4,800,000 gal. would come to Stardust and the other 2,000,000 gal. to Westfield. The sum would be 9,680,000. Weighting the data properly we come out with a blended water which will look like that shown in the last column of Table IV. According to Mr. Lee's figures, this should be excellent water to work with in his cooling tower, and I believe it would not be bad for boiler water. We are already set to handle water like that.

Looking ahead, I am sure that Stardust is going to have to hunt for water even without the drought conditions that exist now. The plant is going to have to go either to large-scale impounding upstream or to use of ground water. Putting this well on Grand River would be a step in the latter direction. It would take care of our present emergency, and would give a little additional security to Westfield itself as another source of water in case of extreme dry conditions.

Hedgepeth: If we decide to go ahead with Mr. Eberman's plan, how is he going to explain to the housewives of Westfield that their water is going to be harder in the future?

Eberman: Actually, I doubt that the housewife will ever notice the difference. The water she has been getting has 220 ppm. of hardness; the blend will contain only 260 ppm. And we can consider our new well as a temporary measure to tide us over while we work out a better long-range solution. Even so, I do not consider that our blending will degrade the water to any essential degree. And the scheme will allow us to meet the emergency within 30 days for no more than about $100,000.

R. E. MORRIS:

Get Good Water From Another Watershed

Summary — Assuming we can hurdle the tremendous legal obstacles in obtaining water from another watershed, we can—at considerable cost—solve our long-range water shortage. For the emergency, however, we cannot expect to receive any help from the Candlewood Reservoir.

IF IT IS necessary to get water outside our reservoir area, we must prepare our case thoroughly and assemble all available data on the subject before requesting an allotment from the authorities. We should very carefully portray our present water requirements and supply, as well as future water requirements and supply. We should show all the measures we have taken to conserve and augment our present supply by reuse of plant waters and reuse of municipal effluents. A consulting engineering firm should make a study of the present and future water supply of the City of Westfield, and the safe yield from this Westfield supply should be determined.

We will have to convince the State Board of Water Engineers of the necessity for going outside our watershed. For example, if it is determined that the safe yield from the Grand River is only 10,000,000 gal. daily, and Westfield is growing and requires more than its present usage of 2,000,000 gal./day (the city now needs 40% of our present 8,000,000 gal., or 3,200,000 gal. more), then we have a good basis for going outside our district, requesting a present allotment of 3,200,000 gal./day, and a future allotment of 50% more.

Similarly we should have a study made of the potential growth and water supplies of Elibom. The best way to approach the problem would be to work out a mutual agreement between our plant and the City of Elibom for the full potential of the Candlewood reservoir. We can never go outside our present drainage area into another drainage area without making it mutually beneficial to all parties involved. We have to make it to their interest if we are to go outside that watershed. They must go with us to the State Board of Water Engineers to get that allotment, and they must be willing to support us all the way through.

Assuming that our argument is looked upon with favor by the State Board of Water Engineers, there would be two ways to obtain the 3,200,000 gal./day of water from this reservoir. The first way would be to establish an intake structure at the Candlewood Reservoir and build a complete pipeline all the way to the plant. That would require staggered pump stations, at about the quarter points. Of course, that would be an impossibility for a 30-day, crash program.

An alternate, and much cheaper route, would be to have one intake structure and pump station at the reservoir, pump over the divide to the upper reaches of Snake Creek, and let the water flow down the Snake Creek to a point opposite the plant about four miles distance. Then build a salt water barrier, another pump station, and a line into the plant.

You will notice (see map) that the first line is about 24 miles long and the short line is only about 4 miles long. So we're talking about 28 miles of pipe. That's a practical impossibility for 30 days and would have to be a permanent solution for the future.

To determine what would be necessary to handle this water we'll assume that we're going to use two 2,500-gpm. pumps from the reservoir—3,600,000 gal./day—a surplus of 12½% over our actual requirements. However, with water flowing down the creek overland, losses of evaporation, transpiration and seepage will be at least 12½%. Some times of the year they will exceed that.

On the 24-mile leg of the pipeline, we would use about an 18-in. line with 140 coefficient of friction. Friction head would be 214 ft., and as-

suming that we'd have to go up over some slight divide between Candlewood and Snake Creek, perhaps 20 ft., we'd have a total head of about 234 ft. So, we'd use 240-ft. pumps, installing two, with one as a standby. Then on the 4-mile stretch, we could probably use 14-in. pipe with a friction head of about 90 ft. We would probably have to lift it about 20 ft. into the plant site, totalling 110 ft., so we'd use 120-ft. pumps.

Assuming a life expectancy of about 20 yr. on the pumps, motors and switchgear, and about 40 yr. on the pipe and concrete works, then annual costs can be proportioned as follows: original investment of $1,893,200 (see Table V), plus a replacement of pumps, motors and switchgear, divided by 40, or $47,575 annual cost spread over a 40-yr. period.

Power and maintenance cost of the pumps, motors, switchgear, and pipeline will run about $15 per 1,000,000 gal. pumped or, over the year, about $18,615, making a total annual cost of $66,190. Assuming that average pumping will be about 3,400,000 gal. between the two stations (taking care of evaporation at both ends), then our cost per 1,000,000 gal. will be about $53/million, or a little over 5 cents/1,000 gal.. This is a little cheaper than we're now getting Westfield water.

But that water will cost roughly 3½ cents/1,000 gal. additional at the reservoir. That will run the price up to about 8.8 cents/1,000 gal., which is more in line with what the other panelists have come up with in their reports.

There are certain advantages of bringing the water from the existing reservoir on the Candlewood River. These are chiefly dependability and the fact that the supply, being near our supply at Westfield, would probably be very nearly of the same type of water and would not need any additional treatment.

There are some disadvantages, of course. It's expensive, and we have the tremendous legal problem of dumping that water on the upper reaches of Snake Creek and letting it flow to the plant.

There is a third disadvantage—the future possibility of Elibom using its power of priority to request the water originally assigned for our plant's usage. That is why it is essential to work out a mutual agreement with the city to make sure that doesn't happen.

Buster (Crown Central): I think the first thing we have to do is to put all these proposals on the same depreciation basis.

Morris: I've found that industrial people don't operate as we do in the City of Dallas. Since most industries wouldn't care to go to an expenditure of $1,893,200 without cutting it down to ten-year depreciation, the best solution might be to work through the City of Elibom, then buy the water from that city at a reduced rate and so get our money back.

Quebedeaux: If we took water from the Candlewood Reservoir and brought it down the pipeline to Snake Creek what rights would others have to the water that we pumped into the creek?

Morris: You're in a very dangerous situation. In this area where they use so much water, your greatest loss is going to be from larceny and not from evaporation. You can get permission to dump water into the river and take it out down below, but the authorities are not going to police it for you, and you have no jurisdiction.

Hedgepeth: You spoke of the legal steps to divert water from one watershed to another. Do they apply to the diversion of ground water from underground into a surface stream? If they do, then that would affect Mr. Eberman's proposal.

Morris: So far as I know there are no laws (in Texas) that apply to ground water diversion.

Comment: Would it be feasible to think of diverting such a small quantity of flow—you're talking about 4 sec.-ft.—into a stream of this length? Wouldn't your infiltration rates, if it's a dry stream bed, be very significant and require you to request considerably more than 4-sec.-ft.?

Estimated Cost of Installation for Pumping From Candlewood—Table V

2 intake structures, including screens and salt water barrier	$100,000
24 miles of 18-in. reinforced concrete water pipe, Class 150	1,625,000
4 miles of 14-in. pipeline	158,000
2 pumps, 2,500 gpm., 240-ft. head	3,800
2 pumps, 2,500 gpm., 110-ft. head	2,800
4 weatherproofed motors	1,000
4 weatherproofed switchgear	1,600
Total	$1,893,200

Morris: From my experience in Dallas, we are losing about 10 to 15% and it flows about 32 miles. We are pumping around 50,000,000 gal. and getting 40,- to 45,000,000 at the point where we want it.

Koenig: There is a fallacy in worrying about seepage and evaporation in using the river for a pipeline, when the river already has water in it. Even if the flow is very low, almost all seepage and evaporation has already taken place and no more will occur unless the river is a very flat one so that its wetted area is greatly increased by a small increment of water. That probably doesn't apply to Grand River. Data have not been given for Snake Creek. If Snake Creek has very low flow, or long periods with no water, then you will have to take into account a considerable amount of seepage and evaporation.

W. E. GIBSON:

Use Sewage Effluent and Air-cooled Exchangers

Summary—We can make a good quality boiler feedwater from the sewage effluent of the City of Westfield, and we can expect a total of about 1,800,000 gal./day from this source. In addition, we can change the plant's cooling system to air-cooled and evaporative type coolers, and save an additional 1,600,000 gal./day in makeup to the present closed cooling system.

TABLE VI shows the quality of the waters of the City of Westfield and the City of Elibom for comparison. It is obvious that Elibom is using a marginal quality of water while Westfield uses the same water that we have at our plant. There is only

Comparative Water Analysis—Table VI

	Westfield	Elibom
Hardness	200	355
Total alkalinity	115	220
Sulfates	65	305
Chlorides	150	170
Silica	9	32

one hitch. Westfield, even when they get their sewage plant built, has only 20,000 population and we can depend on only about 1,800,000 gal./day of municipal sewage effluent from this source. Obviously, that is not enough to make up our 3,200,000 gal./day. deficiency.

But assuming that we could make up the remaining deficit—1,400,000 gal./day—in some other manner, I have decided to stay with Westfield, and later bring out a solution for the other deficiency.

I selected Westfield effluent because of the better quality, but another outstanding factor was location. Westfield is located about 2 miles from our plant, while the sewage disposal plant at Elibom is about 15 miles away—all up hill to our plant. That would require a considerable investment for lines and pumping facilities to move that water to our plant.

I have made an educated guess regarding the quality of sewage effluent we could expect from the City of Westfield, as shown in Table VII. You can compare that against the water supply in Table VI. In using the water, the quality is decreased in every way possible. The hardness, total alkalinity, sulfates, chlorides and silica are all increased. In addition, we have put a big fly in the ointment—a lot of phosphate, primarily orthophosphate and not polyphosphate.

I have studied this sewage effluent for use in our cooling system and also for use in our boiler system as makeup water to supplement the 50% condensate return that we now have. The results from the use of this in cooling water—treating it in our existing clarifier, which we would have to convert to a softener —would not be altogether satisfactory, so I concentrated on boiler feed.

As it exists, the effluent from our hot lime-soda treater, is a fairly good quality of water, at that stage of treatment. We haven't done anything to the sulfates or the chlorides and we have no hope of doing so with this type of treatment. As a topping treatment, I suggest a hot phosphate treater. Our effluent is good quality water—about as good as you can expect in the way of hardness with any type of treater other than a totally softening zeolite treatment, which is expensive. I think hot phosphate would be a cheaper operation. Also, we come out with an excess phosphate of 5 ppm., which makes it pretty nice for our boilers. This is because we are not required to do any direct treatment in the boiler drums from that point on.

Feedwater, diluted exactly 50-50 with condensate, is shown in the last column of Table VII. My conclusion is that we could make good boiler feedwater from the sewage effluent of the City of Westfield.

There are several things to consider in using such water as boiler feed. Even with the best type of treatment we will never remove all of the organics before we put it in the boilers. High temperatures and pressures in the boiler system will break down those organics into ammonia, and our steam and condensate will contain ammonia. If we use this steam for stripping we will have trouble in our chemical plant. But that is a separate problem and will have to be studied from that standpoint.

Ammonia in our steam and condensate is likely to cause corrosion problems on brass and bronze equipment. But there are only a few brass valves, or valves with brass or bronze trim, in our low-pressure condensate system. The valves in our 600-lb. steam system are all-steel valves. Admiralty reboiler tubes are inhibited and they would not be subject to this type of corrosion.

In using this water as boiler feed, we should be able to carry at least a six-times concentration and probably a little higher. Chlorides, silica, and sulfates are the things that would limit us. If we could increase the amount of condensate return, of course that would help.

There is only 1,800,000 gal./day available from this source, which is 1,250 gpm. That leaves us short of our goal, so I've studied some heat loads on the existing cooling system with the thought of converting those loads from a circulating cooling-tower system—which requires a high makeup due to evaporation—to air-cooled units for some products, and evaporative-type air-cooled units on other streams where the product temperature requirements might be lower.

There is about 125,000,000 Btu./hr. being transferred in our plant which could be converted to evaporative-type air-cooled exchangers. These are streams where we're shooting for an outlet temperature of 100-110 F.—in the order of a 20 to 30 F. approach to the ambient wet bulb temperature. This would decrease our water consumption by 420 gpm. or 600,000 gal./day.

Air-cooled units would best be applied to streams with temperature requirements of 140 to 160 F., or higher. It appears that there is about 220,000,000 Btu./hr. being transferred to our circulating cooling system from these streams. If we can convert this 220,000,000 Btu./hr. to straight air-cooled sections, we will decrease our water consumption by 700 gpm., or 1,000,000 gal./day.

Both these types of equipment—evaporative-type air coolers and straight air-cooled sections—are available for an installed cost of about $3,000 per million Btu./hr. of heat transfer. On this basis, we would require an investment of $1,100,000 for such equipment. That money would be well spent, because

Quality of Westfield Waters—Table VII

	Sewage Effluent	Hot Lime-Soda Treater Effluent	Hot Phosphate Treater Effluent	Boiler Feedwater
Hardness	240	16	4	2
Calcium	155	14	3	1
Magnesium	85	2	1	1
Total alkalinity	233	160	144	116
Sulfates	131	131	131	65
Chlorides	200	200	200	100
Silica	30	10	7	3.5
Total phosphates	70	0	5	3

we'd reap benefits, not only in decreased water consumption, but also in decreased operating costs.

The total capital expenditure of $1,100,000 would result in an annual cost—including power for operation of the fans and low-head circulation pumps on the evaporative-type cooling equipment—of $256,000 per year. We should take credit for power that we now are using on high-head and high-volume water circulating pumps in our closed cooling systems. That power is costing us $146,000 per year. In addition to that, we would save 1,600,000 gal./day that we are now purchasing for 6 cents/1,000 gal. from the City of Westfield. Mr. Satterwhite noted that the figure should be 7.25 cents/1,000 gal. delivered to our plant. Using that figure, we would save $42,000 per year in water costs alone. In addition, we are clarifying that water before we put it into our cooling system, this treatment costing us an estimated 7 cents/1,000 gal. This would again result in a saving of $41,000 so that the total amount saved annually would be $229,000. That's balanced off against a total annual cost of $256,000, which would give us a net increase in cost of operation of $27,000 per year.

I haven't taken into account our existing cooling systems, which are already bought and paid for, and are now being depreciated. Maintenance on this equipment is estimated to be 5-7% of the investment cost per year. By the time we take all those factors into account, we can actually effect a net saving in annual operating cost to the company.

These steps would bring our total water relief to more than the amount that we need. The 1,800,000 gal./day obtained as sewage effluent from the City of Westfield, plus the 1,600,000 gal./day that we would save by converting to a different type of cooling equipment, would result in a total daily savings of 3,400,000 gal./day.

Comment: I think it would be desirable to know where our corporation would have to go for a short period—say two weeks or so—to replace this effluent in some sort of plant emergency. I heard of an experience where an activated sludge sewage plant was cursed with what they presumed to be a toxic substance, discharged into the sewers of the community by another industry. This was not the one using the effluent. The result was that the effluent was unusable by the industry who was buying it for a period of some few weeks.

Gibson: The use of sewage effluent is a permanent change, but we can assume that when drought conditions end, we will have river water available in such an emergency.

Comment: Quite often your most difficult periods of sewage treatment plant operation will occur during drought periods. When you have an abundance of rainfall, it's usually a little easier to maintain a good effluent quality.

Wright (Union Carbide Chemical Co.): With the type sewage effluent coming from the treating plant, you have a variation in the concentration of nitrate, nitrite and ammonia already existing. Although I hope I am wrong on this one point, I believe that in 600-lb. boiler equipment you are approaching the decomposition of nitrate to NO_x. Do you know if we would experience any trouble from that standpoint?

Gibson: Another plant has been doing a lot of work on this type of problem and these people are going to use 600-lb. boilers so they evidently feel assured that it is safe. We (Cosden Petroleum Co.) use sewage effluent as boiler feedwater in our plant at Big Spring, but our problem is not severe since we operate at 175 psig. on our boilers.

Baker (Magnolia Petroleum Co.): I would like to make one comment about how much water you can save using fan-type air coolers. We had a plant designed for water cooling. We started drilling water wells and, instead of getting 300 gpm., we started to get quantities like 30 and 15 from these wells. So we had to make radical changes. By using fan coolers and an evaporative type cooling tower (where we used the cool air as well as the cool water), we were able to reduce the waste blowdown from the process cooling in the plant from 100 gpm. to 6 gpm.

Gibson: I will give you another good example. About 6 months ago, we (at Cosden) completed and put into operation a unit that was originally designed for 6,000 gpm. circulation of water. We asked the designers to take a closer look and they came up with the use of air-cooled sections and evaporative-type coolers. Our maximum makeup in the summertime is 66 gpm., as opposed to a figure of 150 gpm. Actually, for three-quarters of the year, makeup is more in the order of 40 gpm.

We (at Cosden) went to this type of cooling as a matter of necessity, but now we are sold on it, and I doubt if we'd change if we could. Our maintenance cost with air-cooled equipment is low compared to shell-and-tube equipment. In addition, we don't have wood deterioration in cooling towers, as is prevalent along the Gulf Coast.

I am not familiar with all the problems on the Gulf Coast, but I understand air cooling is frowned on there because of high humidities and high ambient wet-bulb temperatures. However, no matter how you go about it, cooling must take into account these two factors. It doesn't matter how you do it—you still have these factors to overcome. I can't see that there is any advantage in using a cooling tower over air-cooled equipment.

We have made two installations of the evaporative-type coolers in the past year, and we've succeeded in getting product temperatures within about 20F. of the ambient wet-bulb temperature. As long as you use the same approach as on closed circulating systems, I think you are in the ball-park. You can actually cool the air down to 5-7F. approach to the wet-bulb temperature, which gives a higher temperature differential across the cooling surface and makes for higher efficiency.

One of the big advantages of such evaporative coolers is that you do not have to treat the water, because any scale that might form would be accessible on the outside of the cooling tubes. You can use water that is even less than marginal quality. There are some installations on the Gulf Coast that use brackish water. I don't know that I'd recommend using sea water, but it can be almost that bad, and you can carry quite high concentrations without danger of scaling or fouling.

I imagine some of you are thinking of the fouling of the finned surfaces and of corrosion in the supporting structure. I had an opportunity to see a piece of equip-

ment that had been in operation for five years. It still had the prime coat of paint on the steel structure under the tubular sections, and that is pretty good evidence that there was no corrosion.

Satterwhite: We haven't considered the debits of wood deterioration associated with the use of cooling towers in certain areas. Although our water situation (at Humble) would not drive us to using air-cooled equipment, our wood deterioration problem has been severe, due to both fungus and bacterial attack on redwood. It's a development that has occurred since 1948 when we created environments in which bacteria and fungi are quite prolific. For example, the fill on a cooling tower may be good for six years at most. So, use of air-cooled equipment has another real advantage.

Comment: I think we should note that, unless you use an evaporative-type cooler, you can't cool to a particularly low temperature with air. You're limited in this area to around 140 F. However, by using water to cool the air in evaporative coolers, you can take the last few degrees off each process, either with atmospheric sections or with shell-and-tube exchangers. That works very well and gives you the same process temperatures you are accustomed to, without having to raise the working pressures on all condensers and vessels.

Gibson: That's a good point, and we're doing that. But, in effect, you create a closed circulating cooling system. You will increase the makeup required because you have to cool the water down an extra degree or two by evaporation. The criterion we use in West Texas is to shoot for 100 F. product temperatures with evaporative type cooling. This is a pretty wide range because we design all of our cooling equipment on an ambient wet-bulb temperature of 75 F. With a straight air-cooled section, we shoot for 140 to 150 F.

Lee: It may be that there are some on the Gulf Coast who think air cooling is not practical there. At one time we (at Celanese) knew very little about air coolers and made practically no use of them because we had water available, even though it was a limited supply. We have changed our minds because we built a plant in an arid region and used air coolers. We found that air cooling has certain advantages and that the operating people actually like to use air coolers. As a result, our plant on the Gulf Coast is making extensive use of air coolers in new work.

It seems to me that this revised concept of cooling, which eliminates tremendous quantities of cooling water, should change the thinking that many parts of the country are unsuited for industrial development. We know that we have a limited quantity of water in Texas and it is badly distributed geographically. Therefore, I feel that this trend toward building plants with air-cooled heat exchangers is going to increase and you will see more and more plants using smaller quantities of water in the future.

Hedgepeth: Mr. Gibson, could you give us an idea of the relative costs of conventional cooling towers and air coolers?

Gibson: We have studied this on a number of installations. On the one hand we have pumping costs, long lines, and high-head pumps necessary to circulate water for the closed system. On the other we must move a large quantity of air. We have come to the conclusion that economically, it's even. It costs no more money to go either way. The only difference is that you can cut water usage with air-cooled units.

Comment: What are your water costs in this type evaluation?

Gibson: Our cooling water makeup costs will average around 25 cents/1,000 gal., including total treatment.

Comment: I think that, if your basic water costs were significantly lower than 25 cents, you'd have to re-evaluate the economics.

Gibson: Each installation should stand on its own feet economically. But, let's put it this way: if the water in your area is cheap, but you can't get it—what then?

Comment: I'd like to correct an impression that Mr. Lee apparently has about the use of air coolers on the Gulf Coast. We are using them and we're happy with them. I think that economically they're justified where the temperature differential you want to achieve isn't too far from the ambient temperature of the air. These coolers are here to stay and we will see more of them in the near future. I think we've probably been remiss in not looking closer at evaporative-type coolers, but we're doing a good job with straight air coolers. In fact, we're getting some streams down to 110 F.

Lee: Although we at Celanese haven't studied the economics very completely, we believe that air-cooled units are about equal in capital cost to cooling water installations for fairly high heat-level loads—maybe even cheaper if the load is high enough.

Comment: I'd like to point out some water cooling costs that may not be considered in first evaluating the relative economics. One of these costs is waste disposal. You don't have to dispose of any waste from an air-cooling unit. Sometimes, in arid climates, you have to dispose of wastes by disposal wells—putting it in a salt water stratum. This is not cheap.

Another cost we sometimes don't consider is the engineering and laboratory time that is spent in fooling with systems for cooling water, disposal, and water supply. Engineers are in short supply. Although we may think they don't cost very much, in spite of their being well paid, you can't afford to waste their time. You can't evaluate the engineer's time at his salary alone. You have to evaluate it in terms of what he could be accomplishing for the company at some other work.

Turn page for summary and evaluation.

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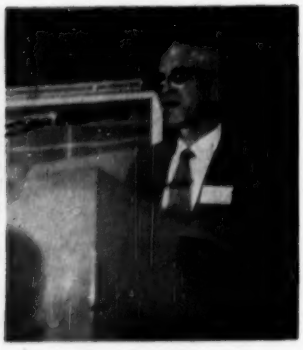


L. L. HEDGEPETH:

Let's Sum Up and Evaluate the Proposals

THE PURPOSE of this meeting has been to devise an emergency program that will provide water for the plant to operate at full capacity within 30 days. In our discussions, we have developed a secondary problem that, in importance, outweighs the primary problem: what are we going to do in the future—10 or 20 years from now—to keep this plant running? The secondary problem is secondary to the emergency only with respect to timing.

Sticking to the emergency problem for the moment, we find that only three possible solutions will meet our emergency requirements in time. The rest must be rejected. The water-use, reuse, and better-use proposals of Lee and Satterwhite, and the Grand River well proposal of Eberman, are the only ones that meet the time requirements.

For the emergency, Mr. Satterwhite has offered a practical, partial solution, which can be put into effect immediately. At best, it will provide us with 1,600,000 gal./day, or something over 50% of our deficiency, and we may accept any or all of his suggestions without prejudice to any other proposals.

Mr. Lee estimates an additional saving of 600,000 gal./day from better cooling tower control. By reducing the phosphate concentration in the cooling water recirculation system, he expects to run a higher total dissolved solids concentration in the cooling water without having calcium phosphate precipitation. That being the case, he can reduce his cooling water blowdown.

However, he proposes to double the chromium discharge from the plant, and this should be examined. With the increased chromium, it has been suggested that we consider mixing the cooling water blowdown with the sludge from the boiler water treatment plant; that we pass this thin slurry to a small clarifier and from this decant the supernatant to the stream and draw the sludge to the industrial waste pond. This has been very successful at other plants and we believe that it would remove the chromium.

The Satterwhite and Lee proposals, totalling a 2,200,000 gal./day saving, will involve an additional capital expenditure of $100,000, and increased operating costs for the plant (including capital service) of $20,000 to $25,000 per year. From experience, we are inclined to reduce the goal for internal economy to 2,000,000 gal./day, which leaves a balance of 1,200,000 gal./day to be procured as new fresh water.

Mr. Eberman has proposed a simple solution: establish a new well field on the banks of Grand River, pump the water into the river and let it flow down into the Westfield reservoir in such quantity that the authorities will not have to enforce their 40% abatement order. The success of this is contingent on two factors: our ability to secure land for a well site, and our ability to satisfy the people of Westfield that we are not degrading their water appreciably.

For the long range program, we have the suggestions of Messrs. Rust and Mr. Gibson, and Mr. Morris' aid in interpreting the state laws and regulations regarding the proposed use of Candlewood Reservoir.

Mr. Rust considers it practical to pump tidal water from the Grand River estuary into our plant for once-through use as cooling water. It is the opinion of people in the plant that they are now getting a 40:1 reuse of the present fresh water. This would mean that, since we use 2,350 gpm. of fresh water for cooling water makeup, something like 90,000 gpm. of tidal water would have to be used for once-through replacement.

That sounds like a staggering figure, but I assure you that it is practical. At one of our company's plants on the Atlantic coast, the cooling load of the entire plant is handled by once-through salt-water coolers. However, use of tidal water in the Stardust plant will require a considerable amount of planning and changes in equipment. It would be impractical for most of the existing equipment in the plant, and would seem to be best suited to provide cooling water for plant expansions and new processes.

Mr. Gibson has proposed the reuse of municipal sewage. I should point out that we make chemicals in this plant and, if any of these chemicals come in contact with that water, it would automatically prohibit them from use in any product intended for the food, drug or cosmetic field. Under regulations of the Federal Food, Drug and Cosmetic Act, anything that comes in contact with a food, drug or cosmetic *is* a food, drug or cosmetic, insofar as the law is concerned. Our industry agrees that only potable water shall come in contact with any of these products.

I'm called on occasionally to define potable water, because it is a mistake to assume that all you have to do is load water up with chlorine to make it potable. We know that isn't the answer, and I think it unlikely that the use of treated sewage could ever be authorized for a plant making products which go into the food, drug or cosmetic fields.

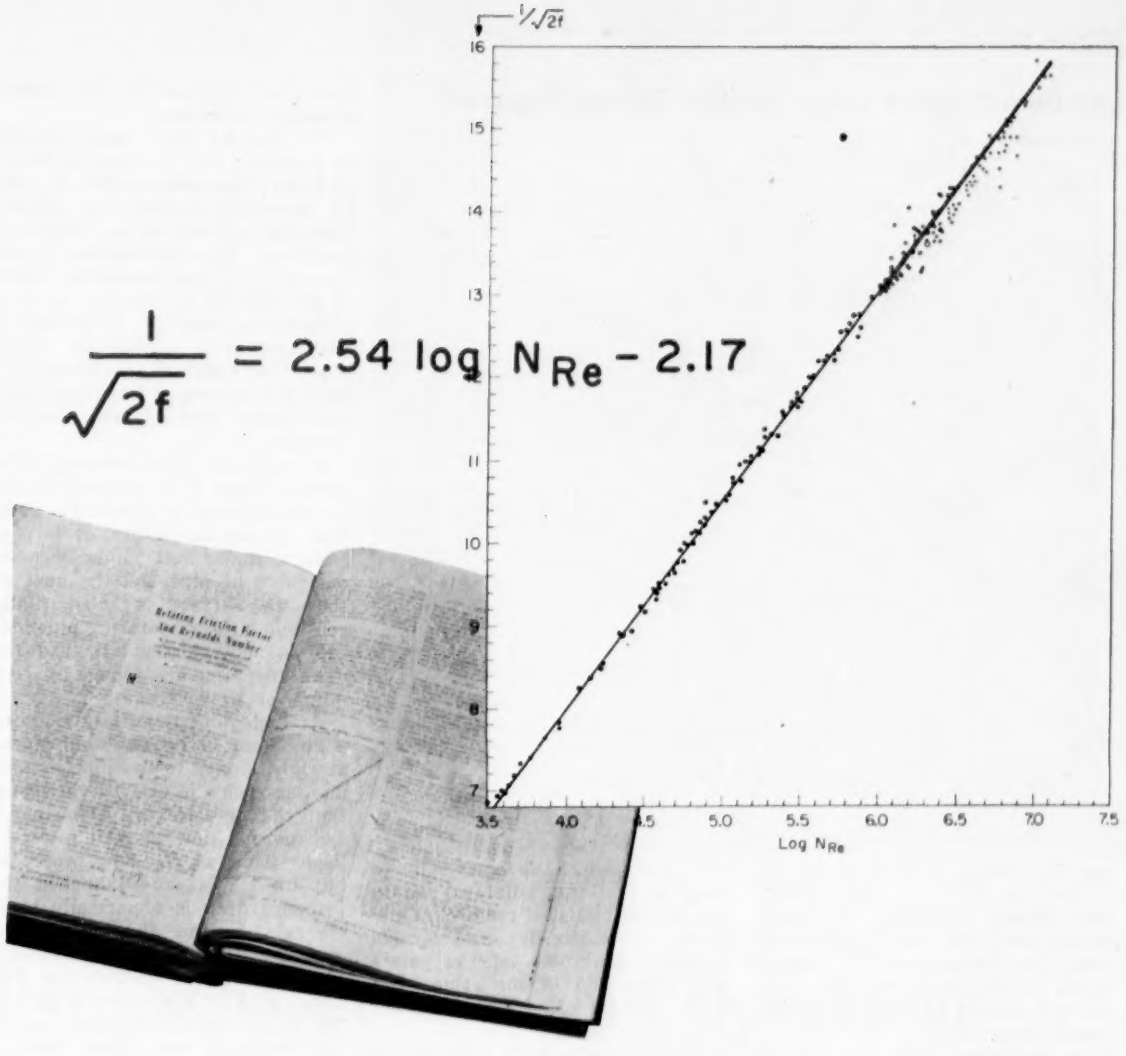
With that exception, however, Mr. Gibson's proposal is practical. In the event that Mr. Eberman's well field should become more mineralized over the years, and we have to make better use of fresh water, this is one good answer.

Mr. Gibson has come up with a very attractive figure. However, it is my judgment that sewage effluent used in a plant such as ours will require filtration, which will add to the cost of the plant.

I might add that in at least four states—Texas, California, Colorado and Maryland—successful use is being made of sewage effluent.

I can't comment on Mr. Gibson's proposals for the use of air-cooled heat exchangers, because I am not familiar with them. However, it appears that such equipment should definitely be considered for this plant.

Looking long-range at Mr. Morris' proposal he has warned us against ever planning to use water from the Candlewood watershed unless we are prepared to prove that we cannot get it from our own watershed and must have it as a matter of economic necessity. Even then, we probably cannot keep it if a public body can show the state authorities that the public needs it.



EVEN FOR REYNOLDS NUMBER IN THE MILLIONS . . .

Equation Gives Friction Factor

Additional data verify validity of linear relation between friction factors and high Reynolds numbers for fluid flow through pipelines.

BENJAMIN MILLER, Consulting Engineer, New York, N. Y.*

About a year ago experimental results[1] on the flow of natural gas through experimental pipelines at high Reynolds numbers became available.

These results give additional confirmation to the relation which I discovered twenty years ago. For turbulent flow in smooth pipe, the relation is that the reciprocal of the square root of the friction factor is a straight-line function of the logarithm of the Reynolds number.

In 1937, the following equation[2] was proposed:

$$1/(2f)^{1/2} = 2.54 \log N_{Re} - 2.17 \quad (1)$$

The friction factor f is defined by

$$2f = Dg \Delta p/L \rho V^2 \quad (2)$$

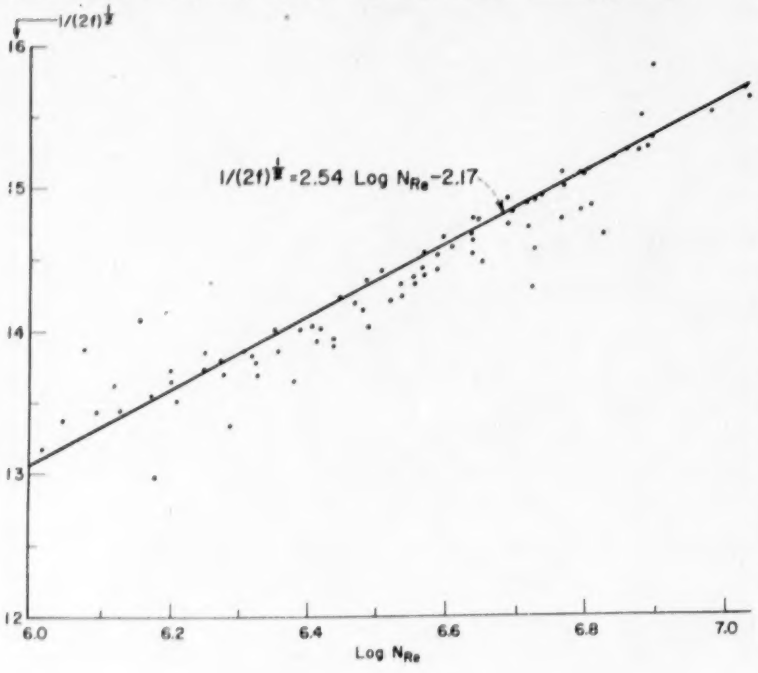
and the Reynolds number N_{Re} by

$$N_{Re} = DV \rho/g \mu \quad (3)$$

where D = diameter of pipe, ft.; g = acceleration of gravity, ft./sec.^{2}; L = length between inlet and outlet, ft.; V = space average fluid velocity (flux in cfs. divided by cross sectional area of pipe in sq. ft.), fps.; Δp = pressure drop between inlet and outlet of the pipe, lb./sq. ft.; μ = viscosity of fluid, lb. sec./sq. ft. and ρ = weight

* Meet your author on page 331

New Data Confirms Linear Relation Between N_{Re} and f



per unit volume of fluid, lb./cu. ft.

The straight-line relationship was purely empirical. It represented very well the experimental data then available which extended from the beginning of turbulence to a Reynolds number somewhat above three million. The 1937 article concluded with the remark "Whether it [Eq. (1)] can safely be used for extrapolation only further experiment can show."

In the absence of further experimental data, it was necessary to extrapolate for pipeline design. The author used Eq. (1) for design purposes up to a Reynolds number of 40,000,000 with satisfactory results. Nevertheless, the desirability of further experimental data was kept in mind.

In the recent study[1] made by the U. S. Bureau of Mines in cooperation with the American Gas Assn. and the State of Oklahoma, tests were run for Reynolds numbers ranging from slightly over 1,000,000 to 10,800,000. This study included tests on a clean, round, straight stainless steel pipe having an inside diameter of 3.008 in.

The 82 test results are plotted in the figure which shows also the straight-line relationship of Eq. (1). The scale of the figure is made large so that the individual points can be distinguished readily. While there is obviously considerable scatter, about 90% of the points fall within 2% of the values predicted by Eq. (1) for the relevant Reynolds numbers.

The tests were made with natural gas flowing under high pressure. Flow rates were measured with a standard orifice meter. Pressure drops across the test pipe were determined with mercury manometers of the electrical resistance-shorting type.

Considering the difficulty of the measurements, it is believed that the differences between the experimental results and the values predicted by Eq. (1) are of the same order of magnitude as the uncertainties in the experimental results themselves.

The pipe sizes, operating pressure levels and flow rates used in modern natural gas transmission lines are such that the Reynolds number generally falls in the 10 to 50 million range. These Reynolds numbers are much greater than the maximum values reached in the laboratory tests made in the thirties. The results of the Bureau of Mines laboratory tests are for that reason especially welcome.

We learned that extrapolation by means of Eq. (1) into the range of higher Reynolds numbers is safe by gradually pushing to higher Reynolds numbers in the design of new lines. The confirmation by the Bureau of Mines laboratory tests of the validity of Eq. (1) up to a Reynolds number of 10 million is naturally quite gratifying. It is hoped that eventually the laboratory tests will be run at Reynolds numbers higher than any now used in practice.

A word of caution remains to be added. There is a substantial difference between a pipe and a pipeline. In the laboratory, it is possible to make butt joints between one piece of pipe and the next so that the surface is substantially continuous. For operating pipelines this is not practical. Instead the pieces of pipe are joined by couplings or by welding.

At each joint there is a ridge or a groove or both. The fluid moves at right angles to the pipe axis in passing such a joint, with the result that the flow pattern is changed. The normal flow pattern re-establishes itself as the flow proceeds; but until it is re-established the pressure drop is abnormally high. Changes in the direction of the average flow caused by elbows, bends, etc., also disturb the flow pattern. The disturbances persist for an appreciable distance, gradually becoming less. These disturbances also cause excessive pressure drops.

Because of the additional pressure drops caused by joints, bends, fittings, etc., the flow through a pipeline is less than would be calculated for a smooth pipe of the same length. This decreased flow occurs even though smooth pipe is used to construct the pipeline. The difference is generally between 5 and 10%, depending upon the relative frequency of the disturbing elements.

A corroded or dirty pipeline will of course have lower flow capacity, but there is no reliable way to estimate how much less.

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WEIGH
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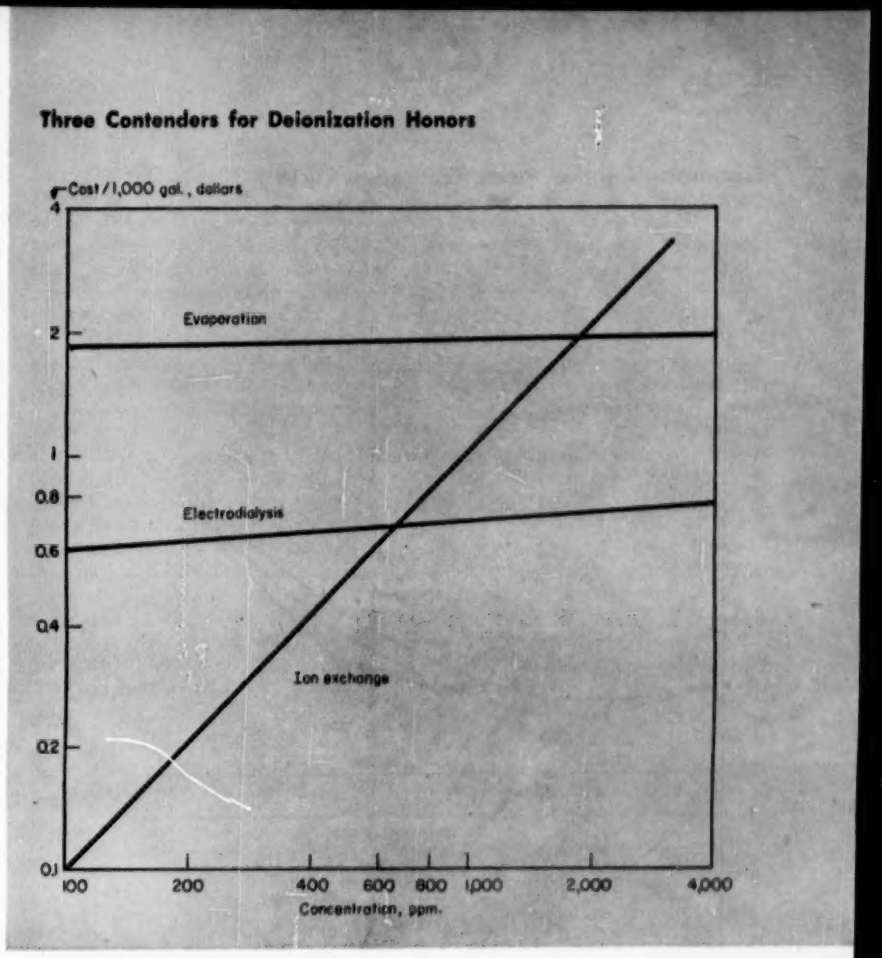


Ion Exchange as a Unit Operation

- What does it accomplish? What does it cost?
- How does it stack up against other methods?

FRANK X. McGARVEY, Rohm & Haas Co., Philadelphia, Pa.*

Over the years there have been many new additions to the list of chemical engineering unit operations. Perhaps one of the most significant and promising of these new additions is ion exchange.

Ion exchange is used to accomplish three basic operations.

• Probably the widest use is to remove small amounts of dissolved salts from polar solvents, generally water. These salts are usually of no value but are objectionable to the use of the water (boiler feed water).

• In a somewhat similar case, ion exchange is used to concentrate a valuable ionized material from dilute solutions as in the case of uranium processing.

• The third case involves an actual fractionation of ionized materials based on the selectivity of the exchangers for the various ions. Separation of rare earths is an example of this process.

* Meet your author on page 332.

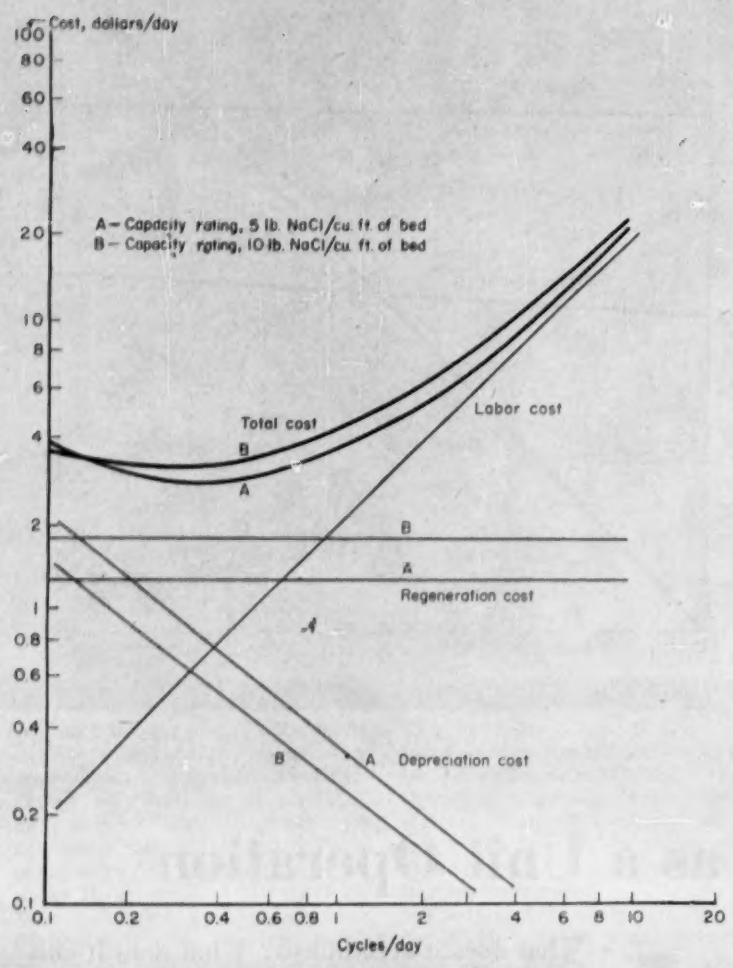
Here's How it Works

As a unit operation, ion exchange is an outgrowth of the widely used processing step called adsorption. Early workers made no distinction between adsorption phenomena and ion exchange.

Today, there is generally wide agreement that ion exchange operates as a chemically reversible interaction between a fixed ionized exchange site and ionized salts in solution. Unless the case being dealt with is the action of a weakly basic anion exchanger, a pure exchange mechanism can be assumed and there isn't any need to look to adsorption mechanisms for an explanation.

Ion exchange resins are cross-linked polymeric materials having fairly fixed structures that contain ion-active groups. For the strongly acidic cation exchangers, the sulfonic acid radical (SO_3H^-) gener-

Economic Balance Finds Optimum Cycle



ally acts as the functional group. Exchangers containing carboxylic radicals ($COOH^-$) are used for special applications. Strongly basic anion exchangers have been prepared which contain quarternary ammonium groups (NH_4^+) while polyamine functional groups have been used to exchange weakly acidic components.

Ion exchange reactions are influenced by the affinity of mixtures of ions for the exchange site. Interchanges can be written in the form of a normal chemical reaction. Using sodium chloride in water as an example:

Cationic exchange

$$Na^+ + H \cdot Resin \underset{\text{regeneration or elution}}{\overset{\text{treatment or saturation}}{\rightleftarrows}} Na \cdot Resin + H^+$$

Anionic Exchange

$$Cl^- + Resin \cdot OH \rightleftarrows Resin \cdot Cl + OH^-$$

These reactions may be studied from mass action equilibrium.

$$K_{NaH} = \frac{(Na \cdot Resin)(H^+)}{(H \cdot Resin)(Na^+)}$$

Potential Resistance Concept

Unit operations involving energy or mass interchanges have been correlated by formulation of a potential resistance concept. This concept has been so successful that filtration, fluid flow, heat transfer, ion exchange, drying, solvent extraction, etc. can be expressed interchangeably by the rate equation:

$$dC/d\theta = \Delta C/RA$$

where R represents a resistance to flow of energy, matter, etc., A the interfacial area, ΔC the driving force and $dC/d\theta$ the interchange capacity per unit time or flux.

This equation is a greatly simplified expression and has only limited use in areas where the resistance and interfacial areas are easily evaluated. It has been applied to ion exchange only in some very approximate situations.

Certain estimates may be made which predict the type of mass transfer to be expected in ion exchange processes. A large interfacial area A is indicated by the relatively small size of the particles and thus a high rate of transfer when compared to heat exchange surfaces. Resistance values R involve diffusional mechanisms and should be of the same order as other transfers across liquid-solid interfaces.

Exchange potentials ΔC are directly related to the concentrations. Relatively small capacities in terms of exchange sites per unit volume limit ion exchange to processes with salt concentrations less than 0.1 N (10,000 ppm.).

Batch or Continuous?

Physically, ion exchange resins consist of spherical beads usually in the size range of 16-50 mesh. Average particle diam. is 0.5 to 0.75 mm. Exchangers are employed as packed beds of these particles, the beds being classified hydraulically and having heights varying from 2 to 6 ft.

Ion exchange operations are carried out for the most part in fixed beds which are regenerated concurrently. Continuous processes for the contacting of the exchange resins and the solution have been studied on a limited scale. Unfortunately, the incentives to develop such processes have not been too great except in cases where a valuable material like uranium is being recovered.

Advantages to continuous operation such as reduced analytical control, fixed effluent concentrations and improved regeneration efficiency are likely to be used up by

Batch Processing vs. Continuous

	Continuous	Batch
Capital investment..	uncertain (high)	low
Labor cost.....	below batch	—
Chemical usage....	below batch	1.5 theor.
Recovery efficiency.	high	high
Recovery conc.....	25/1	20/1
Resin stability, chemical.....	same	same
Resin stability, physical.....	poor	excellent

the increased rate of physical attrition due to movement of the exchange resin.

Information on the subject of continuous ion exchange is limited but from what is available, it doesn't seem likely that significant advantages can be shown for continuous operations except in special cases.

Batch and continuous ion exchange processes are compared in general in the table above.

Finding the Optimum Cycle

Design of the optimum cycle for a particular ion exchange installation involves an interesting interplay of variables. It would best serve our purpose if an illustrative calculation were made to determine the optimum cycle for a plant.

As a typical example, the softening of water will be used. This water will come from a supply which contains 1,360 ppm. (expressed as $CaCO_3$) of total dissolved solids of which 74% (1,000 ppm. as $CaCO_3$) is present as hardness. Plant demand will be 7,000 gal./day (4.9 gpm.).

For the purpose of simplification we'll set up the following assumptions:

- Capacity and leakage values for the calculation of unit size and estimation of regeneration levels to be taken from data on Amberlite IR-120. Since leakage isn't a critical item, a maximum value of 30 ppm. is set and regeneration levels selected will give an efficiency of 0.45 lb. NaCl/kg. hardness removed.
- For this particular water, the resin is rated at 16kg./cu. ft. for 5 lb. NaCl/cu. ft. and 23.5 kg./cu. ft. for 10 lb. NaCl/cu. ft.
- A minimum volume of 2 cu. ft. is based on a flow limitation of 2.5 gpm./cu. ft.
- Cost of equipment is taken from Monet (*Chem. Eng.*, March 1950, p. 106). Depreciation on equipment and resin is set at ten years. No special rental will be charged. No buildings will be depreciated. Taxes and insurance costs aren't included.
- Labor costs are difficult to generalize so that we'll set an arbitrary charge of $2/hr.
- Time for regeneration is taken at one hr.
- Cost of regenerant, in this case NaCl, is set at $0.01/lb.

Basing our calculations on the above assumptions, let's look at the data presented in the first table on this page. Using this data it now becomes possible to calculate cost values so as to arrive at the total cost/day for each of the 18 cases presented. These results are tabulated in the second table.

When these calculations are plotted as a function of the cycles/day, as in the figure on the opposite page, minimum points can be read from the total cost curves. Total cost changes very slowly and is almost independent of the cycle between 0.1 and 1.0 cycles. For this particular set of conditions, since regeneration is constant, the most accurate method is to read the point from the intersection of the depreciation and labor cost curves.

Water Conditioning

Ion exchange is widely used to treat water for various industrial purposes. As a unit operation it is used to reduce solids, soften and dealkalize water.

There are only two processes in competition with ion exchange that

To Determine the Optimum Cycle First Find the Cycles/Day . . .

Run No.	Resin Volume, Cu. Ft.	Bed Cost, Dollars	Regeneration Level, Lb. NaCl/Cu. Ft.	Labor Time, Hr.	Cycles/Day
1	2	170	5	12	13.2
2	10	580	5	3	2.64
3	20	1,000	5	1.5	1.32
4	25	1,200	5	1.0	1.0
5	50	2,000	5	0.5	0.52
6	75	2,800	5	0.35	0.35
7	100	3,500	5	0.26	0.26
8	200	6,000	5	0.13	0.134
9	400	10,000	5	0.07	0.067
10	2	170	10	9.0	9.0
11	10	580	10	2.0	1.8
12	20	1,000	10	0.95	0.90
13	25	1,200	10	0.7	0.7
14	50	2,000	10	0.4	0.37
15	75	2,800	10	0.24	0.24
16	100	3,500	10	0.18	0.18
17	200	6,000	10	0.09	0.09
18	400	10,000	10	0.05	0.045

Then Find the Total Cost

Run No.	Cycles/Day	Depreciation, $/Day	NaCl, Lb./Day	NaCl, $/Day	Labor, $/Day	Total Cost, Dollars	Cost, $/1,000 gal
1	13.2	0.05	130	1.30	24.00	25.35	3.62
2	2.6	0.17	130	1.30	6.00	7.47	1.07
3	1.3	0.27	130	1.30	3.00	4.57	0.65
4	1.0	0.33	130	1.30	2.00	3.63	0.52
5	0.52	0.55	130	1.30	1.00	2.85	0.41
6	0.35	0.77	130	1.30	0.70	2.77	0.39
7	0.26	0.96	130	1.30	0.52	2.78	0.40
8	0.134	1.64	130	1.30	0.26	3.20	0.46
9	0.067	2.74	130	1.30	0.14	4.18	0.59
10	9.0	0.27	180	1.80	18.00	19.85	2.83
11	1.8	0.17	180	1.80	4.60	5.97	0.85
12	0.90	0.27	180	1.80	1.90	3.97	0.57
13	0.70	0.33	180	1.80	1.40	3.53	0.50
14	0.37	0.55	180	1.80	0.80	3.15	0.45
15	0.24	0.77	180	1.80	0.48	3.05	0.44
16	0.18	0.96	180	1.80	0.36	3.12	0.45
17	0.09	1.64	180	1.80	0.18	3.62	0.51
18	0.045	2.74	180	1.80	0.10	4.64	0.63

In Water Purification . . .

Here Are the Factors for Choosing Between Ion Exchange and Evaporation

Ion Exchange

Advantages

- Always available even when no steam is available.
- Requires less floor space than evaporation or precipitation equipment.
- Excellent quality water produced—suitable for nuclear and other special uses.

Disadvantages

- Less economcial in smaller installations.
- Colloidal silica and certain organic materials removed with difficulty.
- Regenerant wastes must be disposed.
- Pilot plant study desirable.

Evaporation

Advantages

- More economical in small installations.
- Simplicity of operation.
- Produces sterile water free of nonionized compounds and high mol. wt. organics.

Disadvantages

- Economics a function of requirements.
- Dependent on steam output and requires auxiliary equipment at startup.
- Requires descaling and other maintenance work.

we'll have to consider. Evaporation, the only other way to produce deionized water, and a chemical precipitation, coagulation, settling and filtration process that will produce a softened, dealkalized water of reduced solids content.

Cost of any deionization process is closely related to specific conditions so that an accurate estimate involves chemical and fuel costs for a particular location. Values shown in the introductory figure, given by Nachod and Shubert ("Ion Exchange Technology," Academic Press, 1956), are based on average conditions. Ion exchange shows an almost linear relationship between solids and chemical costs; these costs having been computed from simple considerations.

Including the value assigned to labor and depreciation, the total cost to deonize water containing 1,000 ppm. total dissolved solids (as $CaCO_3$) is slightly less than \$1/1,000 gal. treated.

Evaporation costs are calculated from the fuel and labor costs. Normally, 1 lb. of steam will be required to evaporate 1 lb. of water. Efficiency of steam utilization can be increased by going to multiple effects. A triple effect evaporator will require slightly more than ⅓ lb. of steam per lb. of water evaporated. For 1,000 gal. of water about 2,800-3,000 lb. of steam will be required. This steam will cost approximately \$1.50-\$1.75. Maintenance charges and fuel losses resulting from scaling of the heat transfer surfaces are reflected by the slight rise in slope of the evaporation curve in the introductory figure.

If you'll examine the question of ion exchange vs. evaporation it becomes clear that this can be resolved by economic considerations. These may include capital investment, operating conditions and operating costs. Excellent water can be produced by both methods. Pros and cons of the two operations are given.

Chemical precipitation processes compete with ion exchange because of their low cost of operation. Usually these plants have large space requirements to accommodate settling basins and sand filters. No direct comparison can be made except that the operating cost may be ½-¾ that required to remove an equivalent amount of hardness by ion exchange. Chemical precipitation processes do not give completely softened or dealkalized water and frequently the processing must be followed by ion exchange equipment. For good operation, the chemical process should operate close to its capacity.

Ion exchange as a water conditioning process is characterized by high flow capacity per unit volume and by excellent reduction of contaminants. Perhaps it is the insensitvity of the exchange system to temporary overloading that makes ion exchange particularly attractive operationally for conditioning of industrial waters.

Use of exchangers, and mixtures of exchangers in fixed beds continues to be standard practice although some fluidized beds are under test. Countercurrent regeneration and continuous processes are developments which may make ion exchange even more valuable in certain cases where it's been difficult to show economic justification for an ion exchange project.

Membrane electrodialysis has been studied as a method for the treatment of brackish water. Initial work was concentrated on the deionization of sea water but pilot plant studies showed this process to be uneconomical. Calcium sulfate and magnesium hydroxide precipitate in the narrow compartments of the cells.

While electrodialysis is not economical for sea water, it presents a real solution for deionization in the concentration range of 3,000-5,000 ppm. By the use of rapid flow rates with a relatively high ratio of wasteage in the concentrated stream, the blockage problem can be minimized.

Cost of ion exchange membrane electrodialysis for deionization is found to be largely independent of total dissolved solids within the range shown in the first graph. It has been estimated (Winger, et. al., *Ind. Eng. Chem.* Jan. 1955, p. 50) that a cell operating on a 25 volt potential will require about 50 kwh./1,000 gal. treated. Cost in this system is a sensitive function of the flow rate, potential and desired depletion of the salt. At \$0.01/kwh., an estimated cost of \$0.50/1,000 gal. is easily derived.

Sugar Processing

Salts impair the production of sugar by reducing the rate of heat transfer and inhibiting crystallization. Molasses contains 5% salts, 50-70% crystallizable sugars and various nitrogeneous colored materials. By pumping this molasses liquor through a series of cation and anion exchange resin beds, it is possible to produce a salt-free sugar syrup which is light in color and almost free of residual color forming bodies.

Cane sugar operations have developed special adaptations of this deionization process to include mixed beds of porous anion and carboxylic cation exchangers. This process is confined primarily to the production of liquid sugars. Where the deionization step has been employed, an increase in yield of 8-12% in cane and slightly higher for beet sugar has been found.

Anion exchange resins to remove color bodies from sugar solutions have received considerable attention. Residual color in these liquors affect the yield of white sugar in the crystallization. In this case a gradual degradation of the exchanger occurs so that the economics are closely bound with the number of cycles of available life in the exchanger.

A typical sugar refinery will treat 2,000-3,000 lb. of sugar solids/ cu. ft. of exchanger. Usually the sugar solution (60% by weight) will be fed to the bed at 180 F. For regeneration, 10 lb. NaCl/cu. ft. of bed will be required. This can be expected to last for 300 cycles. An improvement in the yield of white sugar will result from this treatment, recycle molasses will be reduced and the overall plant yield increased.

Cost of this operation may be estimated roughly as follows:

- Cost of regeneration: 10 lb. NaCl/cu. ft. of bed at \$0.01/lb. = \$0.10/cu. ft. of bed.
- Cost of resin: \$80.00/cu. ft. of bed x 1/300 = \$0.26/cu. ft. of bed.
- Cost of labor: variable but assumed equal to cost of regenerant = \$0.10/cu. ft. of bed.
- Total cost: \$0.46/cu. ft. of bed.

Since each cycle will treat 3,000 lb. of sugar, the cost is only 0.015¢/lb.

Cost of processes that involve deionization of sugar molasses is much higher than the one outlined above. Data shown in the introductory figure are useful in estimation of cost in this operation. A 1% solution may be deionized for a total expenditure of less than \$4.00/1,000 gal. If you assume that this solution contains, as in a typical case, 25 lb. of sugar/100 lb. of liquor, the treatment of 10,000 lb. (about 1,000 gal.) would involve an increase in cost of \$4.00/2,500 lb. of sugar or 0.16¢/lb.

From an operational standpoint, ion exchange is without competition in the sugar industry. Possible exceptions being in the use of bone char and carbon for partial deionization and decolorization. To attain full deionization plus decolorization, it is necessary to use ion exchange. Cost of this process must be carefully evaluated before ion exchange can be employed. Successful use of ion exchange is based on the price of molasses and the value of certain grades of liquid sugar.

Uranium Recovery

A world-wide search for supplies and reserves of uranium revealed that millions of tons of low grade ores exist. When these ores are crushed and leached with sulfuric acid, solutions are obtained that contain less than 1 gram U_3O_8/ liter. These solutions are quite difficult to process for the recovery of uranium due to the huge volume of solutions to be treated.

In 1947 it was reported that uranium salts could be concentrated on anion exchange resins. This is done by the use of a uranyl sulfate complex that is formed as follows:

$$UO_2^{++} + SO_4^{=} \rightleftarrows (UO_2SO_4) \rightleftarrows [UO_2(SO_4)_n]^{2-2n}$$

While the above equilibrium requires more study before all factors can be established, quantitatively, the process of passing sulfated solution through a strongly basic anion exchanger is of great technical interest and large plants have been built to recover uranium from low-grade ores. Probably 90% of the uranium mined today passes through anion exchange resins.

Uranium, once it is bound to an exchanger, can be removed very efficiently by elution with a chloride or nitrate solution. The reactions follows the equation:

$$R_4UO_2(SO_4)_3 + 4NO_3^- \rightleftarrows UO_2^{++} + 3SO_4^{=} + 4RNO_3$$

Resulting solutions, frequently 10-12 fold concentrated in uranium, are precipitated by ammonia, or some alkaline agent. Iron and other contaminants have been washed through the bed ahead of the uranium so that the steps to produce pure U_3O_8 are simplified.

Uranium recovery economics are tied closely to operating conditions of the plant. For example, loading of uranium on beds of Amberlite IRA-400, depending upon the location, varies from 2.5 to 4.5 lb. U_3O_8/cu. ft. of bed. Elution is accomplished with NH_4NO_3 and HNO_3 at a 9-to-1 mole ratio. About 6 lb. NH_4NO_3/cu. ft. of bed is the average amount used. Cost of all reactants involved in ion exchange elution and precipitation amounts to between \$0.35 and \$0.50/cu. ft. of bed. Cost of uranium processing by ion exchange calculates out to \$0.15 to \$0.20/lb.

Cost of liquid extraction techniques are much the same as for conventional ion exchange. This is not surprising since the extractants are what might be called "liquid ion exchange" materials. "Liquid ion exchange" is used as a term to demonstrate the high degree of similarity between these materials and conventional ion exchange materials.

Materials used for solvent extraction recovery of uranium may be divided into two groups. One group consists of high molecular weight amines and phosphate esters which are virtually insoluble in water. These form ionized compounds with the uranyl sulfate complex. A second group consists of high molecular weight phosphate esters that form coordinated, unionized compounds with the uranyl ion. Although the mechanism is different, both classes are used in the same manner and these differences in nomenclature are simply academic. Operations such as liquid-liquid extraction and "liquid ion exchange" can simply be considered as liquid-liquid contacting processes.

Recovery of uranium at pilot plant scale with selective extractants involves elution from the nonaqueous phase with ammonium nitrate followed by precipitation. For a uranium solution of 1 gram/ liter, a cost of \$0.08 to \$0.11/lb. of U_3O_8 has been obtained.

One of the chief factors for selection between the two processes involves a balance between fouling and irreversible poisoning of the exchanger and solubility losses in the extraction process.

Prior to ion exchange, various selective precipitation procedures were available for uranium purification but they could not be adopted to the problem of low-grade ore. Solutions to be handled reached huge proportions.

In addition, ores that cannot be filtered can be processed by a modified ion exchange process called "resin-in-pulp." This process consists of passage of the unfiltered slurry countercurrently through beds of exchanger that are held in baskets made of screens.

Rare Earth Separation

One of the most striking and exciting separations known to chemical technology has been the purification of rare earths by ion exchange. Early efforts to produce pure rare earth fractions involved selective precipitation. Some of these difficult separations required thousands of steps. Cation exchange resins were found to perform equivalent separations in a matter of a few days. Calculations indicated that these beds contained from 1,000 to 1,500 theoretical plates.

For preparative problems, a coupled system has been developed employing a leading section of cation exchanger in the ammonium form followed by a section in the copper or iron form. Rare earth feed solution is loaded on the leading section and then pushed into the copper zone by means of a sequestering agent such as ethylenediamine tetra acetate or nitrilio triacetic acid. By this technique large loadings of various rare earths may be separated and highly purified fractions obtained. While this process is very sensitive to the formation of precipitates, it has found considerable industrial interest.

Plant scale operations yielding hundreds of lb. of purified rare earths/fraction would require large exchanger inventories and numerous beds. Unfortunately the economics of plant scale operations are not yet available for a fair evaluation to be made.

It appears that relatively pure rare earth elements may be recovered by ion exchange for processing costs below $20/lb. of oxide. Recovery of elution agents may further reduce these costs.

Recent developments have indicated that rare earths may be separated by use of solvent extraction processes. These systems employ selective extractants. Cost of extraction processes are significantly less than those employing ion exchange materials due to lowered capital investments and reduced chemical costs. At present, additional ion exchange appears necessary to produce high purity fractions but this will be at a greatly reduced cost if incorporated into a solvent extraction process.

Pharmaceuticals and Organics

Attention should be paid to some interesting separation processes employing ion exchange that have been developed in the pharmaceutical and organic chemical fields. These processes are very similar to those outlined in the previous sections.

Ion exchange resins have many properties that lend them to applications in the organic and pharmaceutical field. As an example, in the early development of streptomycin, carbon was used to absorb the antibiotic from the fermentation broth. This step concentrated the drug and removed the impurities but the carbon couldn't be reused and the elution of "strept" from the carbon was very difficult. A carboxylic cation exchanger in column operation was substituted for the carbon and a much more effective operation resulted. Cost of recovery was reduced to a fraction of that for carbon treatment but more important a greater yield of streptomycin resulted.

A comparison of cost between ion exchange and other methods is quite difficult to arrive at without a detached evaluation of the specifications on the final product. As an illustration, activated carbon will remove an objectionable organic component while ion exchange processes will remove or modify all ionized components in the solution.

Processes involving precipitation, neutralization, etc. are frequently less expensive than the same result accomplished by ion exchange processing. A lime treatment will neutralize an objectionable acidity but thereby introduce calcium salts. Ion exchange will impart a high degree of freedom from ionized impurities to a pharmaceutical or organic substance at a lower cost than most other methods. Cost of desalting is about the same as shown in the introductory figure. Complex separations may be accomplished at costs no higher than those quoted for rare earths.

Recovery of Waste Metals

Recovery of valuable waste contaminants or metals from leach liquors becomes a very critical economic evaluation. Dilute solutions of copper metals at $0.30 to $0.40/lb. and zinc at $0.30/lb. can be treated and these metals concentrated. To process these concentrates and obtain the metals in useable form is another matter and must be considered as part of the recovery system.

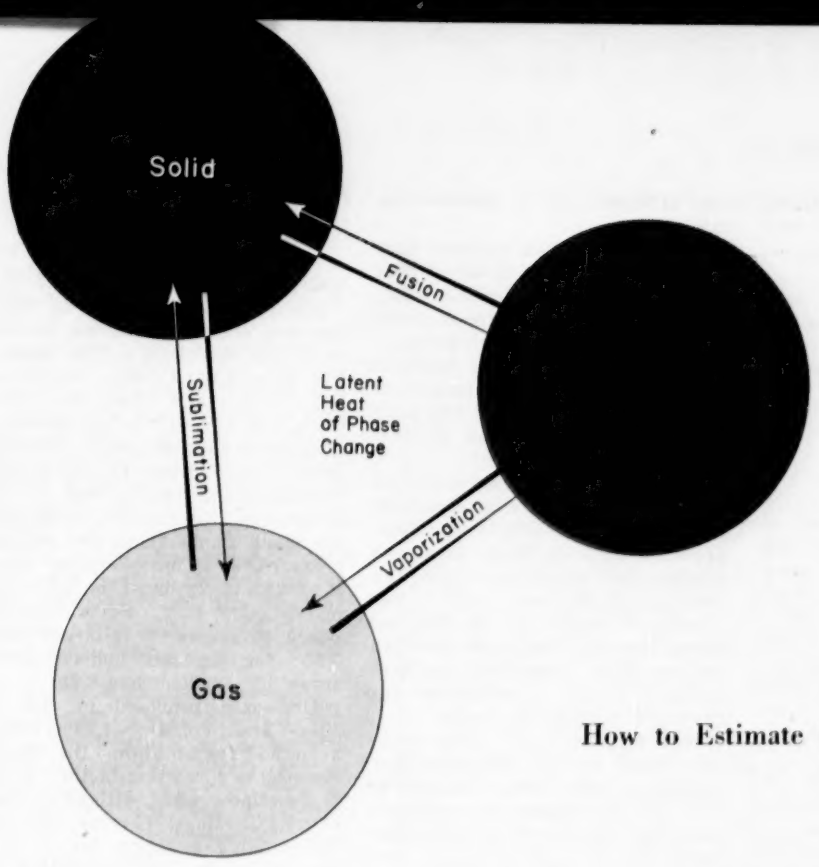
It appears at present that the recovery of metals cannot be economically justified unless the market price is about $0.40/lb. of metal.

Let's Evaluate the Operation

Ion exchange as a unit operation has extremely wide usage. It performs a function that can't be obtained by other operations in the purification of dilute liquors, the conditioning of water, the concentration of valuable materials and the recovery of waste materials.

Selection of a suitable process must be based on an economic evaluation. For a conventional deionization, the practical application of ion exchange is limited by concentration considerations. Normally, a careful economic evaluation is indicated if the amount of dissolved salts to be removed is greater than 0.1%. Of course, the type of salt, and use and value of the deionized solution influence the decision and are the major determining factors.

Separation problems are best tackled from pilot plant data and cannot be analyzed with any rule-of-thumb approach. Future developments will be in continuous and countercurrent operations. It can be expected that new exchangers for specific purposes will appear in the future.



How to Estimate Engineering Properties

. . . Latent Heat—I

Determine Heat of Vaporization

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THIS part of our series will be devoted to methods that you can use to estimate these heat quantities:

- Latent heat of vaporization.
- Latent heat of sublimation.
- Latent heat of fusion.
- Heats of absorption, adsorption and solution.

We'll limit our discussion to these topics only, since heats of combustion, formation, reaction and polymerization are treated extensively elsewhere in the literature. Because of its encompassing generality, we'll discuss the Clapeyron equation first, after which specific methods for calculating latent heats will be treated in detail.

There Are Three

There are three reversible phase changes for which the design engineer requires values of the latent heat of phase change. Solid-liquid contacting calls for a latent heat of fusion; liquid-vapor contacting involves the latent heat of vaporization; and for solid-vapor contacting we speak of the latent heat of sublimation.

For a pure substance, during any of these phase changes the temperature and pressure remain constant and there is observed a transfer of heat (known as the latent heat of phase transition), which is accompanied by a change in volume.

Clapeyron Equation Applies

When we contact phase pairs in saturated equilibrium, the Clapeyron equation (circa 1834) applies exactly:

$$L_t = T(v_2 - v_1)(dp/dT) \qquad (1)$$

where L_t is the molar latent heat of transition; T is absolute temperature; v_2 and v_1 are molar specific volumes of the final and initial phases of the transition process, respectively; and (dp/dT) is the rate of change of equilibrium pressure with temperature—of liquid vapor pressure with temperature for vaporization, of solid vapor pressure with temperature for sublimation and of pressure with freezing point for fusion.

For fusion $v_1 = v_s$ and $v_2 = v_l$; for vaporization, $v_1 = v_l$ and $v_2 = v_g$; for sublimation, $v_1 = v_s$ and $v_2 = v_g$. These specific volumes, or their reciprocal densities, must be orthobaric or equilibrium values for the saturated phases. Also, be sure to use consistent energy units when applying Eq. (1).

Vapor pressure data needed for many of the relations discussed here can be found in many sources. For example, see Stull's work in *Ind. & Eng. Chem.*, Vol. 39, pp. 517-550, 1,684 (1947). Stull presents data for about 1,200 organics and 300 inorganics, with 993 references.

To Simplify Clapeyron

The two approximate forms of the Clapeyron equation given below require fewer data; naturally, they are not as accurate as Eq. (1). They apply either for vaporization

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(latent heat = L_v) or for sublimation (latent heat = L_s), but we'll illustrate them for the case of vaporization only.

Except near the critical point (where $v_l = v_g$), v_l is much smaller than v_g; also, where vapor pressures are small, the vapor will follow the ideal gas law closely. Using these two assumptions, we obtain from Eq. (1):

$$L_V = (RT^2/p)(dp/dT) = RT^2(d \ln p/dT) \quad (2)$$

We might note here that although vapor-pressure data can often be represented well by vapor-pressure equations of the linear log p vs. $1/T$ type, these equations might not be satisfactory for calculating dp/dT. For example, the use of the vapor-pressure equation

$$\log p = -(A/T) + B$$

with Eq. (2) in this form:

$$L_V = -2.3R[d \log p/d(1/T)] \quad (2a)$$

indicates that L_v is independent of temperature, since the expression within the brackets can be set equal to A, a constant. We know this isn't true—that latent heat actually varies inversely with temperature, becoming zero at the critical point.

If, in addition to the two assumptions made above, we take a short temperature range and assume that L_v is constant over this range, we may obtain what is generally called the Clausius-Clapeyron equation (circa 1850). However, the designations "Clausius" and "Clapeyron" are used in the literature in no consistent manner, appearing singly and together. They indicate different equations to different people.

Most often the Clausius-Clapeyron equation is given in this form:

$$L_V = R \ln (p_2/p_1)/[(1/T_1) - (1/T_2)]$$
$$L_V = RT_1T_2 \ln (p_2/p_1)/(T_2 - T_1) \quad (3)$$

This equation gives the average L_v for the temperature range $T_2 - T_1$; it should be used only for short ranges and low pressures.

Methods for Vaporization

A tremendous number of correlations have been proposed over the years for calculating L_v. We have divided these correlations into three areas. First we have the generalized correlations that allow the calculation of latent heat of vaporization at any condition, or only at the normal boiling point. The best of these will be discussed in this issue.

Then we have the methods that predict the variation of latent heat of vaporization with boiling point. We'll get to some of these methods in this installment; and continue in an early issue. These methods can be used to estimate properties of pure substances. A later topic will be methods that can be used for mixtures.

The first four methods discussed below are all good ones, especially Methods 1 and 2. With fewer vapor-pressure data available than one needs to take advantage of the high accuracy of Methods 1 and 2, one should use Method 3 or 4. We have added five additional methods which are useful at times and we have included a list of references for those who wish to dig deeper.

However, nearly all of the methods listed in the supplementary references have been obsoleted or are—for one reason or another—generally inferior to the first nine discussed.

To begin with, the Clapeyron equation may be combined with the "compressibility-factor equation of state":

$$pv = zRT \quad (4)$$

to give, after proper transformation:

$$L_V/\Delta z = RT^2[(d \ln p)/dT] = -R(d \ln p)/d(1/T) \quad (5)$$

where $\Delta z = z_g - z_l = p\,\Delta v/RT = (pv_g/RT) - (pv_l/RT)$

The problem of developing a general correlation for L_v thus reduces to the selection of accurate generalized expressions for Δz and for the vapor-pressure function. Various investigators have selected different functions for Δz and for $(d \ln p)/dT$ and have accordingly proposed equations which often appear to be considerably different from one another at first glance.

However, most of these proposals may be reduced easily to the form of Eq. (5) for comparison. Waring in *Ind. & Eng. Chem.*, Apr. 1954, p. 762, gives $L_v/\Delta z$ equations corresponding to seven vapor-pressure equations.

Method 1—Haggenmacher

Haggenmacher proposed [*Ind. & Eng. Chem.*, Vol. 40, p. 436 (1948)] the use of the Antoine vapor-pressure equation:

$$\log p = A - [B/(t + c)] \quad (6)$$

for the vapor-pressure relation, and the following for Δz:

$$\Delta z = [1 - (p_r/T_r^3)]^{0.5} \quad (7)$$

where $p_r = p/p_c$; and $T_r = T/T_c$.

Haggenmacher's simple Δz relation was obtained from his earlier work [*JACS*, Vol. 66, p. 313 (1944); Vol. 68, p. 1,123 (1946); Vol. 69, p. 707 (1947); and *Phys. Rev.*, Vol. 69, p. 242 (1946)] on an equation of state for saturated fluids. Within about plus or minus 1%, Δz at the normal boiling point is 0.95 for all substances. Note that if pressures are much smaller than the critical pressure, v_l is much smaller than v_g and that Δz must be approximately equal to z_g. For subatmospheric pressures, Δz is larger than 0.95; for superatmospheric pressures, it's smaller than 0.95.

Dreisbach proposed in *Ind. & Eng. Chem.*, Vol. 41, p. 1,749 (1949) a method for obtaining the "Haggenmacher correction factor," as Δz is sometimes called, without the use of critical values. This method uses the defining equation for Δz, see line below Eq. (5), predicting v_g from a modified Antoine equation and v_l from the law of rectilinear diameters.

The present result for L_v, combining Eqs. (5), (6) and (7), is:

$$L_V = \frac{4.576BT^2\,\Delta z}{(t + c)^2} \quad (8)$$

where L_v = cal./gram-mole; T is in deg. K.; t is in deg. C.; B and C are constants from Eq. (6); and Δz is from Eq. (7).

Eq. (8) applies to both polar and nonpolar compounds, and is not restricted to the normal boiling point. Deviations for L_v values calculated anywhere in the liquid range will be small, less than 1% in the original study for 17 liquids well below their critical points, and only a few % at the most for liquids in the higher-pressure regions from my own studies at Union Carbide.

If only two boiling points are available, let C of Eq. (6) equal 230 and calculate B from:

$$B = (t_1 + 230)(t_2 + 230) \log (p_1/p_2) \div (t_1 - t_2) \quad (9)$$

Method 2—Thomson

Thomson in *Chem. Rev.*, Vol. 38, p. 1 (1946) also uses the Antoine equation for the vapor-pressure function of Eq. (5). However, for Δz Thomson proposes:

a) For $p_r/T_r = 0$ to 0.2,

$$\log \Delta z = 2.106x^3 - 1.0268x \quad (10)$$

b) For $p_r/T_r = 0.2$ to 1.0, we can use the equation:

$$\log \Delta z = 0.136x^2 - 0.645x - 0.0185$$

c) For the useful range of p_r/T_r smaller than 0.1, use the simpler,

$$\Delta z = 1 - (0.97p_r/T_r)$$

where in Eqs. (10a) and (10b),

$$x = -\log [1 - (p_r/T_r)] \quad (11)$$

Thomson's final relation is thus also Eq. (8), but with a different Δz correlation (a correlation which checks I.C.T. data for polar ethanol to within 0.5% avg. up to $T_r = 0.97$).

With good vapor-pressure data the error is about the same as for Haggenmacher's relation, but the latter's Δz correlation is obviously more convenient.

Method 3—Klein and Kharbarda

Klein [*Chem. Eng. Progress*, Vol. 45, p. 675 (1949)] and Kharbarda (*The Ind. Chemist*, March 1955, p. 124) each use Haggenmacher's Δz relation, Eq. (7), but use simple two-constant vapor-pressure equations. Klein used:

$$\log p = -(A/T) + B$$

and Kharbarda:

$$\log p = A - (B/T)$$

Each arrived at the same final equation, which in reduced form is:

$$L_V = \frac{4.576T \log P_r \Delta z}{(T_r - 1)} \quad (12)$$

where L_v is in cal./gram-mole; and T is in deg. K.

Since the vapor-pressure equations used here are not as precise as the Antoine equation—which is probably the best all-around three-constant equation—we find errors somewhat higher, about 4% avg. and 10% maximum.

Arnold and Raiford (*Chem. Eng.*, April 1951, p. 138) present a nomograph of a correlation similar to Eq. (12) which was derived by Watson in *Ind. & Eng. Chem.*, Vol. 35, p. 398 (1943) for the normal boiling point only. This derivation uses the Calingaert-Davis vapor-pressure equation [*Ind. & Eng. Chem.*, Vol. 17, p. 1,287 (1925)]:

$$\ln p = A - [B/(T - 43)] \quad (13)$$

and a value of 0.95 for Δz at the normal boiling point.

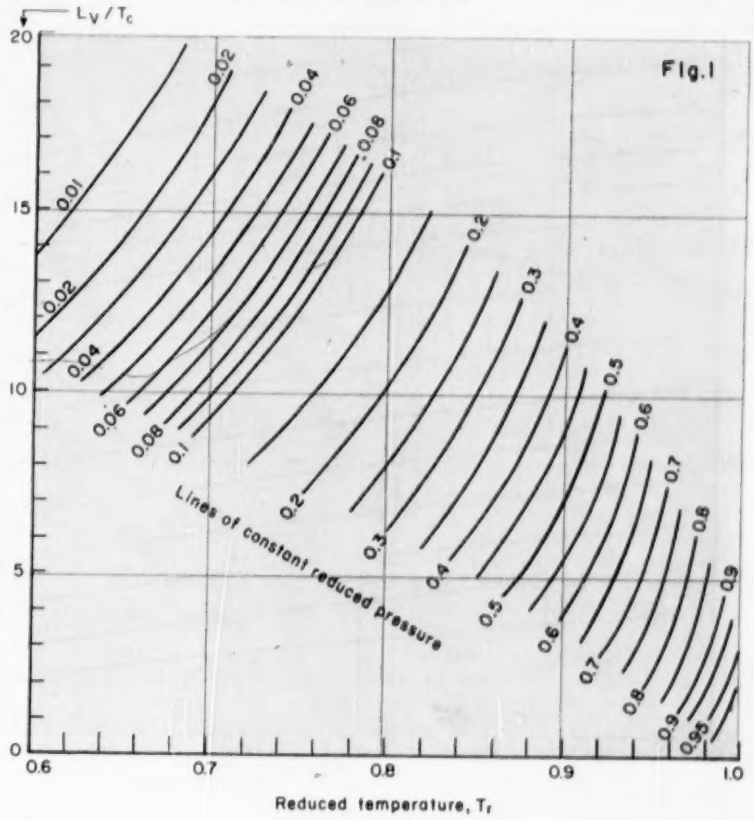
Method 4—Meissner

Meissner [*Ind. & Eng. Chem.*, Vol. 33, p. 1,440 (1941)], using the vapor-pressure equation

$$\ln p = -(A/T) + B$$

also derived Eq. (12); and using a previous correlation of Δz vs. T_r and P_r, [Meissner and Paddison, *Ind. & Eng. Chem.*, Vol. 33, p. 1,189 (1941)], developed another graphical correlation for L_v. We show this as Fig. 1.

Meissner Chart Saves Calculation



The average error here is also 4-5%; the method involves little calculation but has the inherent uncertainty of the chart interpolation. Reduced presure is, of course, reduced vapor pressure here; and T_r is the reduced temperature corresponding to it.

Method 5—Kistyakowsky

In *Z. Physik. Chem.*, Vol. 107, p. 65 (1923), Kistyakowsky proposed an equation, applying only to the normal boiling point, which is in excellent agreement with experimental results for a wide variety of nonpolar liquids (plus or minus 3% for 60 liquids). However, the method cannot be used for polar liquids such as water, ammonia, aldehydes, etc., for which it predicts low results. The equation is:

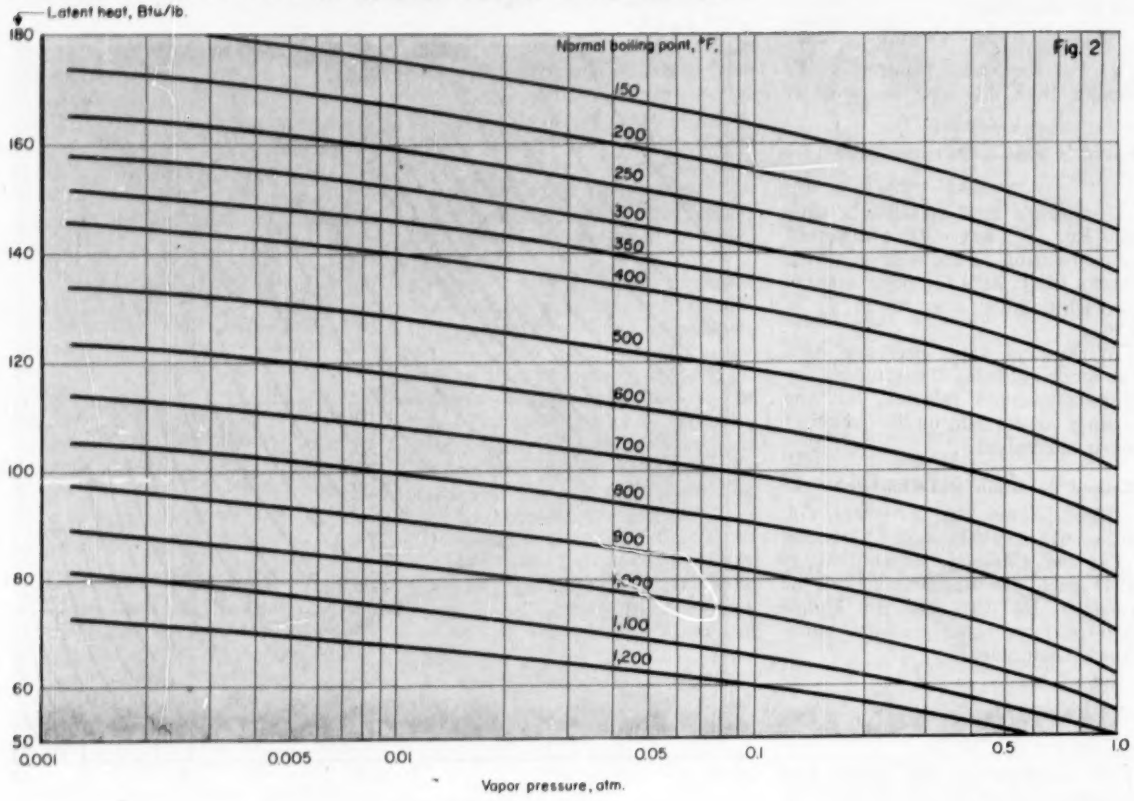
$$L_V/T_b = 8.75 + 4.571 \log T_b \quad (14)$$

where L_v is in cal./gram-mole, at T_b; T_b = normal boiling point, deg. K.; and L_v/T_b is the molar entropy of vaporization.

For the special class of alkylbenzenes, Griswold and May (*Petroleum Refiner*, March 1947, p. 88) found 8.0 and 5.0 to be better constants, correlating the data for 14 compounds within 0.6%. Chu, et al., in *Ind. & Eng. Chem.*, Vol. 41, p. 131 (1949), applied Eq. (14) to the development of an involved method applicable to paraffin hydrocarbons.

More importantly, the Kistyakowsky equation was thoroughly investigated by Chipman, in *J. Phys. Chem.*, Vol. 32, p. 1,528 (1928), who found it to hold well from 5 to 7,000 K. Chipman used L_v and T_b data for He, H_2, Ne, N_2, A, O_2, etc., in the low-temperature range; and for metals such as Cd, Pb, Fe and Cu, for the high-temperature range. It proved superior to other equations

Maxwell's Data for Paraffin Hydrocarbons (Low Pressures)



that involve only L_v and T_b—especially for temperatures below 100 K. and above 1,000 K. This is doubtless due to the theoretical derivation of Eq. (14); it contains no empirical constants—only the universal gas constant—in its original form.

Chipman, in *J. Phys. Chem.*, Vol. 33, pp. 131-135 (1929), derived interesting ratios with which one may multiply calculated results from Eq. (14) to obtain more accurate answers. The average ratio values for four common classes are given in the table below. Note that the whole right-hand side of Eq. (14) is to be multiplied by the ratio H/H_s.

Class	H/H_s
Hydrocarbons	1.014
C_nH_s-halide	1.030
Esters	1.072
Alcohols (except methyl)	1.296

Method 6—Landee and Whittier

Landee and Whittier of the Dow Chemical Co., Midland, Mich., have developed a novel correlation procedure which can be reduced to the following expression for the case of L_v taken at the normal boiling point, T_b:

$$L_V = \frac{0.29 T_b^{1.6} M^{0.6}}{N^{0.9} \rho^{0.15}} \qquad (15)$$

where L_v is in cal./gram-mole; T_b = deg. K.; M = molecular weight; N = number of atoms/molecule; and ρ = density of liquid in grams/cc. at 20 C.

For several branched-chain alkanes the writer found a 2½% average error and a 4% maximum error.

Method 7—Trouton's Rule

Trouton's rule as published in *Phil. Mag.*, Vol. 18, p. 54 (1884), should be at least mentioned in passing since it's one of our oldest prediction methods and one that has been modified many times over. The rule is:

$$L_V/T_b = 21 \text{ (approx.)} \qquad (16)$$

where the units are cal./gram mole-°K.

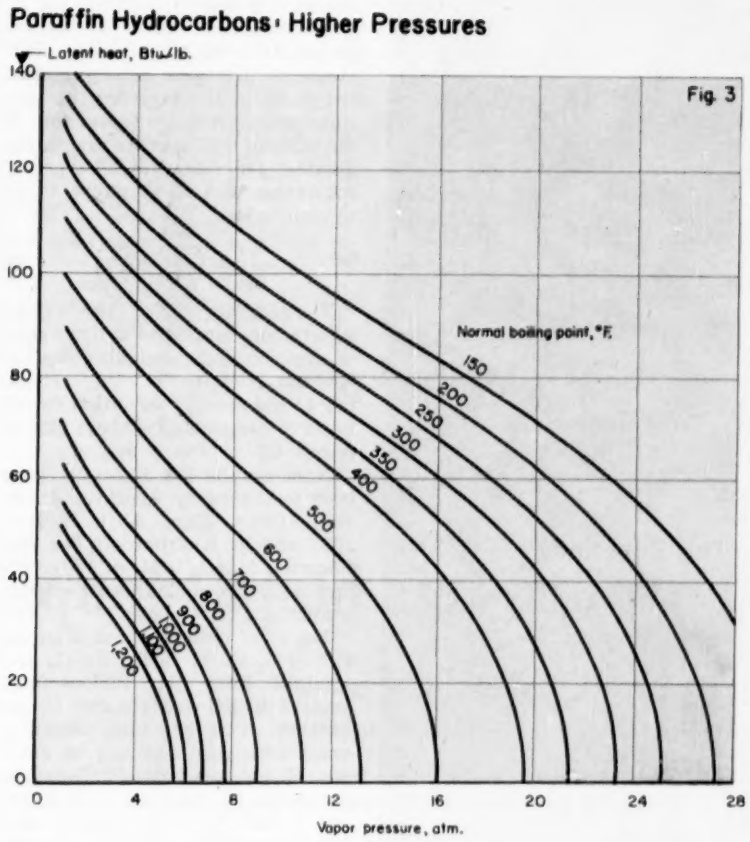
Actually, the constant varies from 6 for helium to 27 for ethanol; and from 15-26 for normally encountered liquids. The average for normal liquids is 20.7 plus or minus 0.8. One of the more recent and interesting modifications is given by Bowden in *J. Appl. Chem.*, Vol. 4, p. 38 (1954).

Method 8—Maxwell

The latent heats of the paraffin-hydrocarbons, as shown by Maxwell first in *Ind. & Eng. Chem.*, Vol. 24, p. 502 (1932) and then "Data Book on Hydrocarbons," pp. 96-97, D. Van Nostrand, Princeton, N. J. (1950), are given in Figs. 2 and 3. Here L_v is plotted vs. vapor pressure at given temperatures, and normal boiling point.

Method 9—Reference Substances

The application of reference-substance plots to the correlation of L_v will be found in the following sec-



tion on the variation of L_v with temperature.

Other Selected References

For those who wish to dig deeper into this subject, here is a selected list of additional references:

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2. Bingham, *JACS*, Vol. 28, p. 723 (1906).
3. Hildebrand, *JACS*, Vol. 37, p. 970 (1915).
4. Hooks and Kerze, *Chem. Eng.*, April 1946, p. 117.
5. Lewis and Weber, *Ind. & Eng. Chem.*, Vol. 14, p. 485 (1922).
6. Mathews, *J. Phys. Chem.*, Vol. 20, p. 554 (1916).
7. Maxwell, *Ind. & Eng. Chem.*, Vol. 24, p. 502 (1932).
8. McAdams and Morrell, *Ind. & Eng. Chem.*, Vol. 16, p. 375 (1924).
9. Mortimer, *JACS*, Vol. 44, p. 1,429 (1922).
10. Pollara, *J. Phys. Chem.*, Vol. 46, p. 1,163 (1942).
11. Prud'homme, *J. Chim. Phys.*, Vol. 21, p. 461 (1924).
12. Schultz, *Ind. & Eng. Chem.*, Vol. 22, p. 785 (1930).
13. Telang, *Current Science*, Vol. 11, p. 461 (1942).
14. Telang, *J. Indian Chem. Soc.*, Vol. 20, p. 271 (1943).
15. Thomas, *J. Chem. Soc.* (London), p. 3,415 (1949).
16. Tripathi, *J. Indian Chem. Soc.*, Vol. 20, p. 197 (1943).

Variation With Temperature

Often you have available a single value of the latent heat of vaporization at a given temperature—usually the normal boiling point—but need a value at a different temperature. A number of excellent methods are available for this calculation.

One can, of course, use any of the previous L_v correlations not restricted to the normal boiling point, such as those of Haggenmacher and Meissner, and compute values for any number of temperatures. By calculating the deviation between any single known value of L_v and that calculated for the same conditions, and then assuming that this deviation remains constant with temperature, one can reduce an already small error to an even smaller one over a wide temperature range.

Also, over a moderate temperature range, say less than 100 deg. C., latent heat is practically a linear function of temperature. One could use the relation

$$L_v = A - BT$$

with good accuracy. The latent heat

Proposed Values for the Exponent n in Eq. (18). (See Method 1, next page.)

Value of n	Proponent	Reference
0.333	Thiesen	*Verhl. d. D. Phys. Ges.*, **16**, p. 80 (1897).
0.333	Nutting	*Ind. & Eng. Chem.*, **22**, 771 (1930).
0.375 (for constant mol. wt. of vapor)	Kordes	*Z. Electrochem.*, **58**, p. 424 (1954).
0.38	De Hemptinne	*Bull. Acad. Roy. Belg.*, **12**, p. 296 (1926).
0.38	Watson	*Ind. & Eng. Chem.*, **35**, p. 398 (1943).
0.386 (for normal liquids)	Kendall	*JACS*, **36**, p. 1, 620 (1914).
0.393 (for unassociated liquids)	Bowden and Jones	*Phil. Mag.*, **37**, p. 480 (1946).
0.4	Winter	*J. Phys. Chem.*, **32**, p. 576 (1928).
0.4	De Wijs	*Rec. Trav. Chem.*, **62**, pp. 449, 455 (1943); and *J. Phys. Chem.*, **54**, p. 599 (1950).
0.4	Bowden	*J. Chem. Phys.*, Dec. 1955.

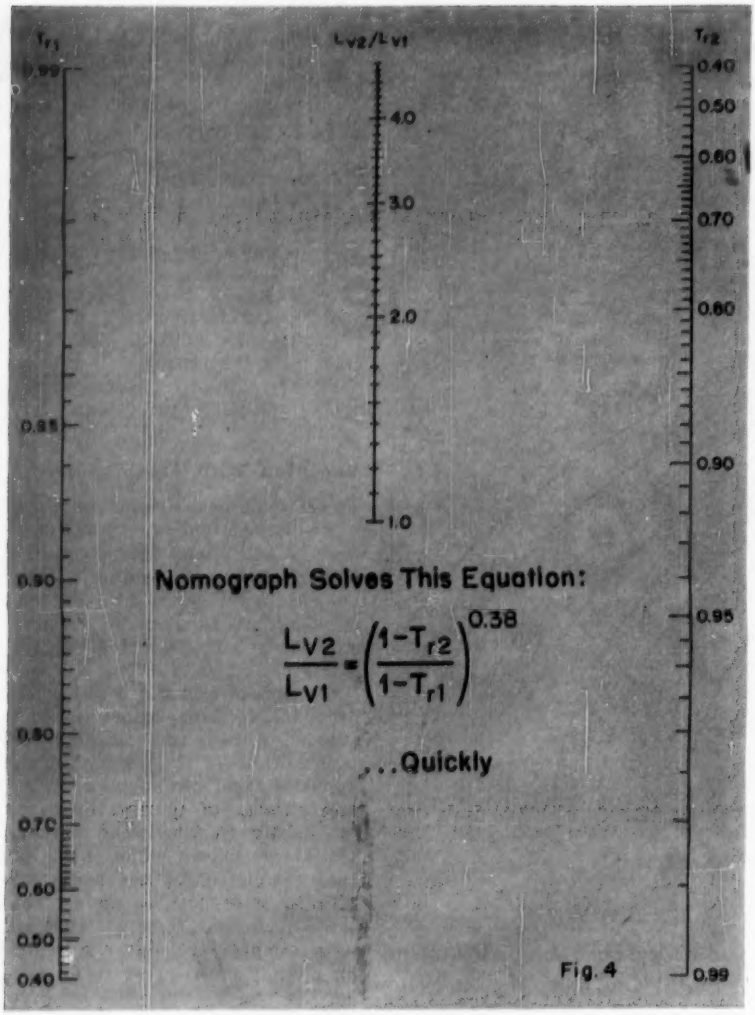

Fig. 4

of vaporization falls with rising temperature, becoming zero at the critical point.

The first two of the generalized methods presented (one here and a second in an early issue) are chosen for their combination of accuracy and simplicity which makes them so useful for engineering purposes. After these, we'll discuss methods that may be as accurate but may not be as convenient.

Method 1—"Theisen's Correlation"

A function of the form:

$$L_V = k(T_c - T)^n$$

or

$$L_V = k(1 - T_r)^n \qquad (17)$$

(where k and n are constants; T_c is absolute critical temperature; and T_r is reduced temperature), has been proposed, tested and discussed in the literature no fewer than ten times, the first time by Theisen in 1897.

When the equation is applied to two temperature levels and the equation for one level is divided by that for the other, we obtain the following:

$$\frac{L_{V2}}{L_{V1}} = \left(\frac{T_c - T_2}{T_c - T_1}\right)^n = \left(\frac{1 - T_{r2}}{1 - T_{r1}}\right)^n \qquad (18)$$

which we latter-day chemical engineers recognize as the "Watson relation" for relating latent heat of vaporization with absolute temperature.

It has been observed that the exponent n is nearly universal for all substances. The values of the exponent, in order of ascending magnitude, which have been proposed are given in the table on the previous page. Of these values for n, the value of 0.38 appears to give the greatest generality for all types of substances and is therefore to be recommended:

$$\frac{L_{V2}}{L_{V1}} = \left(\frac{T_c - T_2}{T_c - T_1}\right)^{0.38} \qquad (19)$$

The accuracy of Eq. (19) is quite satisfactory over the entire range of available data, including the immediate vicinity of the critical point; the average deviation for all types of compounds is about plus or minus 4%.

Nomographs for Eq. (19) have been published by Arnold and Raiford (*Chem. Eng.*, April 1951, p. 139) and by Kharbarda (*The Ind. Chemist*, March 1955, p. 126). We have reproduced Kharbarda's nomograph as Fig. 4 above.

Eq. (17) indicates that a log-log plot of L_V vs. $(1 - T_r)$ should give straight lines for various substances which are parallel to one another. This has been shown to apply with good accuracy by Johnson, Huang and Kwei in *Chemistry in Canada*, March 1954, p. 38. Knowing T_c and L_V as a function of T for a reference substance (water, for example), and T_c and L_V at any single temperature for a given substance, one may determine the entire L_V function for the substance being considered.

Merely draw a straight line on the log-log plot through the single known point and parallel to the reference-substance line.

As mentioned above, this is only a start on the methods that can be used to predict the variation of latest heat of vaporization with temperature.

Look for a continuation of this discussion in a forthcoming issue.

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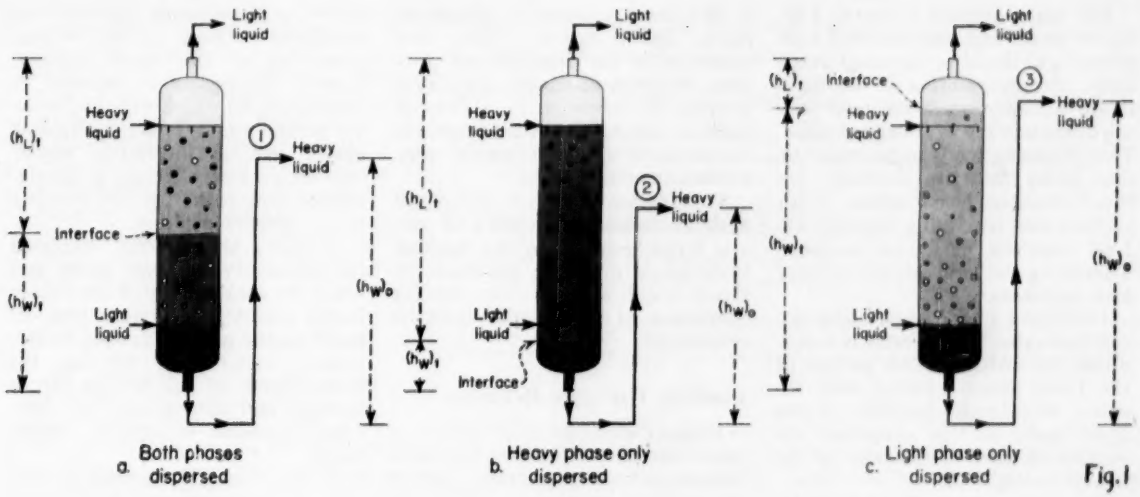

Fig. 1

Liquid-Liquid Flow in Packed Towers

How to predict flow relations in liquid-liquid systems. Empirical correlations and their limitations are explained in this article.

MAX LEVA, Consulting Chemical Engineer, Pittsburgh, Pa.
C. Y. WEN, West Virginia University, Morgantown, W. Va.*

In the broadest sense, liquid-liquid contactors are devices that bring about a state of subdivision of two liquids in each other. Since this is a very widespread problem in chemical engineering, it is not surprising that a large variety of units have been proposed.

It is beyond the scope of our article to review the many equipment types; since only in recent years have significant contributions[9, 10, 13] been made in this field. Instead our attention is focused on the correlations of flow data that pertain to liquid-liquid contacting in gravity-operated packed towers. We will also examine packing behavior when preferential wetting by either phase occurs.

The term gravity-operated provides the clue as far as mechanical driving force is concerned. For a packed tower to function economically, the two practically immiscible liquids must have a sufficient difference in density to induce and to maintain the traffic of the phases in the tower.

* Meet your authors on pp. 333 and 338.

How the Contactors Function

Before discussing flow correlations in liquid-liquid packed tower systems, it is desirable to review briefly the manipulation of such equipment. Thereby, we also define some specific basic concepts.[12]

Let Fig. 1 represent a packed tower carrying a liquid-liquid system. The light and heavy liquids enter the tower by means of distributors located in the base and top of the unit respectively. With the heavy liquid overflow fixed and densities of the liquid specified, there is an interface at a definite position in the tower. The position of the interface is readily defined by the various hydrostatic heads.

Let us consider the most general case as shown by Fig. 1*a*. If we designate the hydrostatic head of the heavy liquid in the overflow by $(h_W)_o$, that of the heavy liquid in the tower with and without the dispersed light phase by $(h_w{}^d)_i$ and $(h_w{}^c)_i$, respectively and the respective heads of the light phase by $(h_L{}^d)_i$ and $(h_L{}^c)_i$, there follows:

$$(h_W)_o = (h_W{}^d + h_W{}^c)_i + (h_L{}^d + h_L{}^c)_i$$

If the unit operates well below flooding there is relatively little of either phase dispersed in the other. For this reason the preceding equation may be reduced to

$$(h_W)_o = (h_W)_i + (h_L)_i$$

This simple relation defines the position of the interface. For the case shown in Fig. 1*a* and the overflow in Position 1, the interface is near the center of the column. Therefore, the two liquids are in the dispersed as well as continuous phase.

If the overflow is lowered to Position 2 as shown in Fig. 1*b* the position of the interface has been lowered somewhat below the inlet of the light phase. This causes the light phase to become continuous, with heavy liquid now descending in dispersed form as drops.

Similarly if the overflow is raised, say to Position 3 as indicated in Fig. 1*c*, the interface may then adjust itself above the heavy liquid feed point. For this condition then the heavy liquid becomes continuous and the light phase ascends in droplets.

(*Continued*)

For the conditions shown in Fig. 1*c*, let us assume that the feed rate of the light liquid is increased gradually. Drop formation of the light liquid becomes more frequent and the drops will try to crowd together. This crowding tends to decrease the flow paths that are available for the continuous heavy phase. With its feed rate remaining constant, its local velocities must now increase. Therefore its local kinetic energy also increases.

Continued increases of light liquid feed rates finally result in a condition for which the flow pattern of the light phase becomes very erratic. Eventually portions of the light liquid may be swept out the bottom of the packed tower by the heavy liquid.

When this occurs the tower appears to fill with light liquid. The unit is then said to be flooded. As with gas-liquid systems, satisfactory operation is then no longer possible.

In this instance flooding is approached by gradually increasing the light liquid rate to a tower that operates under a constant rate of the heavy liquid. Since this is a reciprocal phenomenon, flooding of the tower also results if the light liquid feed rate remains unchanged while the heavy liquid rate is stepped up beyond a permissible value.

Approach to flooding in gas-liquid systems is always characterized by a significant increase in dispersed phase liquid holdup. This also seems true for liquid-liquid systems. Whereas flooding in gas-liquid systems is preceded by a definite loading range, the counterpart in liquid-liquid systems seems very much obscured.

The reason is that in gas-liquid systems wetting properties of only one liquid relative to the packing material is involved. However, in liquid-liquid systems the wetting properties of both liquids must be considered.

Packing Use and Behavior

Dumped Raschig rings and to a lesser extent saddles are the most frequently used packings in packed liquid-liquid contactors. Sizes of packings employed in industrial units may vary from ¼ to 1½ in. nominal size. Beyond the 2-in. size the rings are usually stacked. The functioning of stacked rings resembles in many ways the performance of grids.

Virtually no fundamental studies have been reported for the larger sizes of stacked rings and grids. The reason for the non-availability of such data is the excessive cost which such experimental investigations entail. On the other hand publication of detailed performance data on existing commercial units are not usually available.

The function of the packing in a liquid-liquid contactor depends to a considerable extent on the wetting properties of the liquid system. Thus if the system is operated so that the liquid which wets the packing preferentially is the continuous phase, then the interstitial spaces between packing elements primarily become flow paths for the droplets of the dispersed phase.

In effect the packing increases the tortuosity of these paths and hence the contact time of the phases in the tower. The surface area offered by the packing is then of secondary importance; whereas the homogeniety of the bed as far as voidage and arrangement are concerned becomes of primary importance.

If the system is operated in such a way that the dispersed phase preferentially wets the packing, then there is tendency toward film flow over the packing. In this instance the surface area of the packing becomes more important in determining flow characteristics of the bed.

However, homogeniety and absence of pattern packing are still fundamental requirements so that the surface area of the packing also becomes available. Furthermore, a homogeneous packing structure will aid uniform phase displacement and thereby is essential for maintaining true counter-current operation of the tower.

Regardless of which phase pref-

Liquid–Liquid Flooding Studies of Small Diameter Towers

Reference	Tower Diameter, In.	Density, ρ_c Lb./Cu. Ft.	Density, ρ_d Lb./Cu. Ft.	Difference in Density, $\Delta\rho$ Lb./Cu. Ft.	Viscosity, μ_c Centipoise	Viscosity, μ_d Centipoise	Surface Tension, σ Dyne/Cm.
Ballard and Piret	3.75 2.03	61.3 to 62.2	46.0 to 99.2	6.4 to 37.0	0.894 to 1.24	.....	7.5 to 46.2
Breckenfield and Wilke	2.6	49.5 to 99.0	49.5 to 62.4	8.4 to 37.2	0.62 to 2.77	0.59 to 0.98	8.9 to 37.6
Crawford and Wilke	12.	49.5 to 99.0	49.0 to 71.3	9.4 to 37.2	0.579 to 7.77	0.579 to 6.99	8.9 to 44.8
Dell and Pratt	3. 6.	62.4 to 69.9	43.1 to 100.	7.49 to 37.4	1.04 to 5.70	0.50 to 2.52	8.6 to 46.5
Taketani, Sato and Nishida	3.9	61.4 to 62.4	54.7 to 57.5	5.0 to 7.67	0.98 to 1.85	0.58 to 2.68	.....
Fujita, Kikuzawa and Watanabe	1.81 2.16	50.7 to 62.4	51.2 to 62.4	7.49 to 11.35	1.77 to 10.1	0.91 to 29.2	6.8 to 28.3
Hoffing and Lockhart	6	61.6 to 79.1	50.0 to 95.0	4.36 to 32.4	1.00 to 38.0	0.80 to 70.0	11.8 to 46.0

erentially wets the packing, it is desirable to provide as high an interstitial voidage as possible. The order of magnitude of the individual voids spaces should be consistent with such shapes and sizes of packings which provide the largest interstitial openings. As would be expected great importance is attached to the design of packing supports and liquid distributors in these systems.

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Compare Flooding Correlations

All correlations are based essentially on a state of flooding as described earlier in this article. In the case of Ballard and Piret[1] liquid velocities are referred to what they termed a "transition point." This reference point pertains to a modification in flow mechanism and behavior observed when the liquid rate exceeds a certain value. The liquid considered here is the one which preferentially wets the packing and is present as the continuous phase.

As the authors point out, their reference point does not coincide with the reference point of other investigators. However, it appears to precede flooding. Furthermore, they point out that a different flow mechanism prevails when the liquid that preferentially wets the packing is passed through the column as a dispersed rather than a continuous phase.

Correlations proposed by various investigators are given on the next page. Symbols and dimensions as originally proposed are retained. The range of the variables upon which the correlations are based is given in the table below.

The five correlations listed show very little resemblance to each other. Still they are intended to permit estimation of limiting flows in liquid-liquid packed systems and hence the sizing of towers. Just how much disagreement or agreement there is may best be examined by analyzing a typical problem.

Example Illustrates Methods

Let an extraction column operate with the system water-toluene. The packing is 1-in. Raschig rings. Process conditions are such that a volumentric ratio of water to toluene equal to two is desirable and satisfactory. With water the continuous phase, estimate the limiting tower diameter for which a total of 50,000 lb./hr. of water contacts the proper amount of toluene.

Physical properties and packing constants are as follows:

a = 58 sq. ft./cu. ft.
$\Delta\rho$ = 8.4 lb./cu. ft.
ϵ = 0.73
μ_c = 0.894 centipoise
μ_d = 0.6 centipoise
ρ_a = 62.2 lb./cu. ft.
ρ_d = 53.8 lb./cu. ft.
σ_{ca} = 67.0 dynes/cm.
σ_{cd} = 35.0 dynes/cm.
σ_{da} = 27.1 dynes/cm.

The meanings of the subscripts: a = air, c = continuous phase and d = dispersed phase.

Applying these data to the various correlations gives tower diameters as follows:

Correlation	Tower Diameter, Ft.
Ballard and Piret	4.41
Breckenfield and Wilke	3.12
Crawford and Wilke	3.49
Dell and Pratt	3.04
Hoffing and Lockhart	3.12

With the exception of the Ballard and Piret correlation, the calculated data for this particular diameter are in very good agreement. The choice of a different reference state in the Ballard and Piret formula results in the larger column diameter.

All correlations appear to give the column diameter with a sufficient order of accuracy to be quite useful for most engineering evaluations. Interestingly enough the greatest deviation is observed between the values obtained from the correlations of Breckenfield and Wilke and Crawford and Wilke. Normally this result is not to be expected.

Packings
0.25 and 0.5-in. porcelain Raschig rings.
0.25-porcelain Raschig rings; 0.5-in. porcelain Berl saddles; 0.5-in. Raschig rings and clay spheres.
0.5, 1.0 and 1.5-in. carbon Raschig rings.
0.25 and 0.375-in. porcelain Raschig rings; 0.5, 0.75 and 1.0-in. stoneware Raschig rings; 0.25 and 0.375-in. stainless steel Raschig rings; 0.375 and 0.5-in. stoneware Lessing rings; 0.25-in. porcelain Berl saddles and 0.5 and 1.0-in. stoneware Berl saddles.
0.354-in. porcelain Raschig rings
0.276 and 0.394-in. aluminum Lessing rings; 0.63-in. porcelain Raschig rings and 0.5-in. Berl saddles.
0.5, 0.75 and 1.0-in. Raschig rings.

Estimate Limiting Flow With These Correlations

Ballard and Piret[1]

$$0.55\,\frac{g^{0.278}\,\Delta\rho^{0.465}}{U_w^{0.5}\rho_w^{0.415}\mu_w^{0.05}}\left(\frac{\epsilon}{a^{0.65}}\right)^{0.5}\left(\frac{\sigma_{ws}+\sigma_{ss}}{\sigma_{ws}}\right)^{0.2}=1.70\left(\frac{U_s}{U_w}\right)^{0.5}\left(\frac{\rho_s}{\rho_w}\right)^{0.3}+1$$

- a Surface area factor for packing, 1/ft. For ¼-in. porcelain Raschig ring, a = 202 sq. ft./cu. ft. For ½-in. porcelain Raschig ring, a = about 90 sq. ft./cu. ft.
- g Gravitational constant 417 × 10^8 ft./hr.²
- $\Delta\rho$ Density difference, lb./cu. ft.
- U Superficial fluid velocity, ft./hr.
- ϵ Fractional free volume of packing, dimensionless
- μ Viscosity, lb./hr.-ft.
- ρ Density, lb./cu. ft.
- σ_{ss} Surface tension of solvent phase measured against air, erg/sq. cm.
- σ_{ws} Surface tension of water phase measured against air, erg/sq. cm.
- σ_{ws} Interfacial tension between water and solvent, erg/sq. cm.

Subscripts

- s Organic solvent or other fluid not preferentially wetting the packing.
- w Water or other fluid preferentially wetting the packing.

Breckenfield and Wilke[2]

$$\frac{U_c\sigma^{0.34}\mu_c^{0.33}a^{0.8}}{\Delta\rho\epsilon^2}=\frac{3{,}980}{[1+(U_d/U_c)^{0.5}]^2}$$

- a Surface area of packing per unit volume, sq. ft./cu. ft.
- U_c Superficial velocity of continuous phase, ft./hr.
- U_d Superficial velocity of dispersed phase, ft./hr.
- $\Delta\rho$ Density difference between phases, lb./cu. ft.
- ϵ Void fraction of packing.
- μ_c Viscosity of continuous phase, centipoise.
- σ Interfacial tension, dyne/cm.

Crawford and Wilke[3]

For $N_{Re} < 50$: $$(U_c^{0.5}+U_d^{0.5})=147{,}000\,\frac{\Delta\rho^{1.33}\epsilon^2}{\rho_c^{0.73}a^{1.0}\mu_c^{0.33}\sigma^{0.27}}$$

For $N_{Re} > 50$: $$(U_c^{0.5}+U_d^{0.5})=19{,}800\,\frac{\Delta\rho\epsilon^{1.5}}{\rho_c^{0.5}a^{0.5}\sigma^{0.2}}$$

Nomenclature same as for Breckenfield and Wilke

Dell and Pratt[4]

$$\left[1+0.835\left(\frac{\rho_d}{\rho_c}\right)^{0.25}\left(\frac{V_d}{V_c}\right)^{0.5}\right]=C_2\left[\left(\frac{V_c^2a}{g\epsilon^3}\right)\left(\frac{\rho_c}{\Delta\rho}\right)\gamma^{0.25}\right]^{-0.25}$$

- a Superficial area of packing, sq. ft./cu. ft.
- g Gravitational constant, ft./hr.²
- V Superficial velocity, ft./hr.
- γ Interfacial tension, dyne/cm.
- $\Delta\rho$ Density difference, lb./cu. ft.
- ϵ Fractional voidage of packing.
- μ Viscosity, lb./hr.-ft.
- ρ Density, lb./cu. ft.

Subscripts

- c Continuous phase
- d Dispersed phase

For Dell and Pratt equation, use these values of C_2

Packing	Size In.	C_2	Packing	Size In.	C_2
Raschig rings	< ½	0.68	Lessing rings	⅜ to ½	0.80
Raschig rings	½ to ¾	0.77	Spheres	½	0.80
Raschig rings	1	0.82	Berl saddles	¼	0.68
			Berl saddles	½ to 1	0.88

Hoffing and Lockhart[7]

$$U_w=\left[\frac{f(R)\,\Delta\rho^{0.54}}{3.33\times10^{-6}\rho_s^{0.22}\rho_w^{0.10}\mu_s^{0.03}\mu_w^{0.10}(\sigma_{ws}/\sigma_{ws})^{0.5}(a/\epsilon^{1.3})}\right]^{1.25}\times R^{0.25}$$

- a Surface area of packing, sq. ft./cu. ft.
- R Ratio of U_s/U_w
- $f(R)$ Functional relation given in original article.
- U_s Velocity of solvent, cu. ft./sq. ft.-hr.
- U_w Velocity of water phase, cu. ft./sq. ft.-hr.
- $\Delta\rho$ Density difference between phases, gram/cc.
- ϵ Fractional void volume in bed
- ρ_s Density of solvent, gram/cc.
- ρ_w Density of water phase, gram/cc.
- μ_s Viscosity of solvent, centipoise
- μ_w Viscosity of water phase, centipoise
- σ_{ws} Interfacial tension for aqueous phase to air, dyne/cm.
- σ_{ws} Interfacial tension for aqueous phase to solvent phase, dyne/cm.

However, the good agreement noted may be fortuitous. There may be conditions for the various correlations (except for the Ballard and Piret expression) which may produce widely varying estimates. Thus the various effects, that have been taken into account, may to a large extent cancel each other.

The results may then give the impression of agreement where there really may be a large area of disagreement. In any event for the purpose of making commercial estimates, we recommend that the answers from all the correlations be examined and thereafter render judgment.

Dispersed Phase Holdup

The first comprehensive study of holdup in packed liquid-liquid extraction columns was reported by Gayler, Roberts and Pratt.[6] Their investigation was preceded by the work of Lewis, Jones and Pratt[8] who investigated drop size in this type of equipment. A more recent study of liquid-liquid holdup was reported by Wicks and Beckman.[13] Experimental conditions and limits of variables are indicated in an adjoining table.

In studies of this kind we would obviously examine the behavior of the dispersed phase. This is analogous to the behavior of the liquid phase in a gas-liquid system. Some typical data of Pratt and associates are given in the figure. Here dispersed phase holdup is shown in relation to dispersed phase velocity for a range of continuous phase velocities.

Essentially three observations were made. For low dispersed phase rates the drops appear to rise freely and relatively unhindered between the voids of the packing. The holdup is then found to increase almost linearly with dispersed phase rate.

A point of lower transition or loading is observed when the holdup is about 10 to 15%. Beyond this point the rate of increase of holdup with dispersed phase rate is quite rapid. This is interpreted as the start of a hindered settling effect.

Finally a third holdup region is reached at about 50%. This is termed the upper transition point. Above this point the droplets coalesce rapidly and flooding occurs.

The investigators believe that the mechanism of droplet flow is a analogous to the hindered settling of suspensions. This leads to an interesting approach toward correlation.

The method of correlation of Wicks and Beckman is more empirical. Three types of holdup prevail which are termed free, operational and total.

The free holdup comprises the dispersed phase drops that rise freely to the interface. Operational holdup comprises the free holdup in addition to droplets freed from the packing elements by virtue of pulsation that may have prevailed in the continuous phase flow. Total holdup designates the entire holdup of the dispersed phase within the effective packing volume.

Qualitatively, it is observed that holdup increases as packing size decreases. Operation with ring sizes of $\frac{1}{2}$ in. and larger seems to be different than operation with smaller packings. The $\frac{3}{8}$ in. rings are believed to represent a critical or transitional packing between $\frac{1}{2}$ in. and $\frac{1}{4}$ in. rings.

Thus with the larger packings the droplets seem to be rising more freely and are relatively well defined. With the small rings, the dispersed phase seems to move up in the form of irregularly shaped globules. These have a strong tendency to adhere to the packing in the interstices.

Wicks and Beckman found that packing density deviations have an important effect on holdup and hence on reproducibility of results. Accordingly they suggest an improved method of packing experimental columns so as to obtain a practical maximum packed bed density.

This is achieved by charging the column in the normal way. The packing is dropped into the water-filled tower. Thereafter the tower is operated with air for about 15 min. at a liquid rate that keeps the tower flooding. This technique causes a slow shifting of the packing elements and tends to produce a maximum packed density of the bed.

Correlation of Holdup Data

Lewis, Jones and Pratt

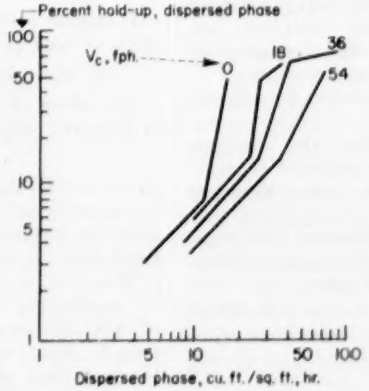
Tower: 2 in. diameter
Packing: Porcelain Raschig rings, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in.; stainless steel Raschig rings, $\frac{3}{8}$ in. and Berl saddles, $\frac{1}{2}$ in.
Density ρ_c: 62.4 to 69.9 lb./cu. ft.
Density ρ_d: 43.2 to 99.8 lb./cu. ft.
Difference in density $\Delta\rho$: 7.1 to 37.4 lb./cu. ft.
Viscosity μ_c: 1.0 to 5.7 centipoise
Viscosity μ_d: 0.64 to 2.52 centipoise
Surface tension σ: 8.6 to 46.5 dyne/cm.

Gayler, Roberts and Pratt

Tower: 3, 6 and 12 in. diameter
Packing: Ceramic Raschig rings, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in.; ceramic Berl saddles, $\frac{1}{4}$, $\frac{1}{2}$ and 1 in.
Density ρ_c: 62.2 to 67.3 lb./cu. ft.
Density ρ_d: 43.2 to 56.4 lb./cu. ft.
Difference in density $\Delta\rho$: 5.8 to 12.2 lb./cu. ft.
Viscosity μ_c: 1.0 to 2.82 centipoise
Viscosity μ_d: 0.48 to 0.64 centipoise
Surface tension σ: 6.5 to 41.8 dyne/cm.

Wicks and Beckman

Tower: 3, 4, and 6 in. diameter
Packing: Porcelain Raschig rings, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$ and 1 in.
Density ρ_c: 62.4 lb./cu. ft.
Density ρ_d: 53.8 lb./cu. ft.
Difference in density $\Delta\rho$: 8.6 lb./cu. ft.
Viscosity μ_c: 1.0 centipoise
Viscosity μ_d: 0.6 centipoise
Surface tension σ: 35 dyne/cm.



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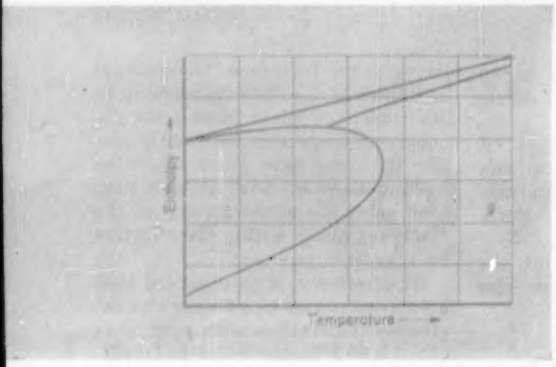

Enthalpy and Entropy

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PROCESS engineers often face the problem of determining the thermodynamic properties of hydrocarbon mixtures. Unfortunately, the amount of experimental thermodynamic data on mixtures is quite limited; and if one is concerned with systems of more than two components, the data are virtually nonexistent.

From a practical standpoint, it would be impossible to obtain sufficient experimental data to define clearly the thermodynamic networks of all possible mixtures. Therefore, the process engineer must resort to approximations in most instances.

Lack of information on liquid-phase behavior and a limited knowledge of vapor-phase behavior in multicomponent mixtures have hampered the development of accurate generalized procedures, particularly at high pressure. Despite these difficulties, a number of methods have been suggested as practical solutions to the problem of determining the thermodynamic properties of mixtures. The design engineer should understand how to use these methods as well as the assumptions and limitations involved in their use.

As in previous parts of this series, we'll limit our discussion to the enthalpy and entropy functions.

Basic Relations Depend on Reference State

The enthalpy function for either pure substances or mixtures is invariably expressed relative to some arbitrary reference state. While the selection of the reference state is a relatively simple matter in the case of pure components, it can be quite complex for mixtures and selection is based on the kind of data available.

There are five reference states frequently used for mixtures. They are:

1. The pure components as they actually exist at some given temperature and pressure.
2. An infinitely dilute solution of one component in another at some given temperature and pressure.
3. A specific mixture of the components at a given temperature and pressure.
4. The components of the mixture in the ideal-gas state, unit fugacity and a given temperature.
5. The components of the mixture in the ideal-gas state, unit fugacity and 0 R.

Most often the fourth and fifth reference states are used because the need for heat of mixing data is eliminated, this effect being zero for ideal gases.

If the fifth reference state is used, the procedures for calculating the thermodynamic properties of a given mixture in the gas phase are similar to those used for pure compounds (*Chem. Eng.*, Nov. 1957, p. 245). First, the enthalpy of the gas mixture in the ideal-gas state at the desired temperature is calculated by:

$$H_m^\circ = \int_{T_{ref.}}^{T} \Sigma y_i C_P^\circ dT \qquad (1)$$

or,

$$H_m^\circ = \Sigma y_i H_i^\circ \qquad (1a)$$

Next, we find the effect of pressure on enthalpy under isothermal conditions:

$$(dH)_T = [V - T(\partial V/\partial T)_P]\, dP \qquad (2)$$

This is the same expression that is used for this calculation when dealing with pure compounds. Naturally, *P-V-T* data for the specific mixture must be available. The total enthalpy of the mixture is obtained by summing the results calculated with Eqs. (1) and (2).

Same Applies for Entropy

As in the case of the enthalpy function, the entropy function is expressed relative to some arbitrary reference state. Usually—but not always—the same reference state is used for both functions. For the purpose of illustration, we'll use the same reference state throughout this article.

Calculating the entropy of a mixture differs in one important respect from the enthalpy determination, because the entropy of mixing must be taken into account. For ideal gases, it's easy to show that the entropy of mixing is:

$$\Delta S_{mixing} = -R \Sigma y_i \ln y_i \qquad (3)$$

It follows that the entropy of a mixture in the ideal-gas state and at a given temperature is represented by:

$$S_m^\circ = \Sigma y_i S_i^\circ - R \Sigma y_i \ln y_i \qquad (4)$$

The effect of pressure on entropy under conditions of constant temperature can then be calculated by:

$$(dS)_T = -(\partial V/\partial T)_P\, dP \qquad (5)$$

which is the relationship used for this calculation when considering pure compounds. The total entropy of the mixture is determined by summing the results obtained from Eqs. (4) and (5).

Thus far we have limited our discussion to methods for evaluating the derived thermodynamic properties of mixtures in the gas phase. Enthalpy and entropy data for liquid mixtures can be obtained by subtracting the enthalpy or entropy of vaporization from their

* To meet your authors, see *Chem. Eng.*, Nov. 1957, pp. 332 and 328.

Data for Hydrocarbon Mixtures

respective values in the gas phase. We have discussed latent heats of vaporization for mixtures in a previous part of this series of articles (*Petroleum Processing*, Sept. 1957, p. 153).

A more general solution to the problem of predicting thermodynamic properties of mixtures is available through the use of partial quantities. Considering the enthalpy function, the total enthalpy of a mixture may be separated into partial quantities. The relationship is:

$$H_m = \Sigma z_i H_i \quad (6)$$

where H represents the partial enthalpy of a component and is a function of temperature, pressure and composition.

Partial enthalpies may be calculated from an equation similar to Eq. (2). However, the partial volume of a component is used in place of the total volume of the mixture; and the change in partial volume, instead of the change in total volume with respect to temperature at constant pressure is also used.

Analogous to Eq. (6), the relation between total volume and partial volume is:

$$V = \Sigma z_i v_i \quad (7)$$

where v is the partial volume of a component.

Use These Calculation Methods

Pure Component Method—The simplest way to estimate the enthalpy of a mixture is to sum the product of the enthalpy and the mole fraction of the individual components in the mixture:

$$H_m = \Sigma z_i H_i \quad (8)$$

This procedure is completely valid only for an ideal solution. However, Eq. (8) can be used for mixtures of real gases provided the pressure is moderate and the temperature is high (approximately the critical temperature or greater).

Eq. (8) may also be applied to the liquid phase; but as was the case in the vapor phase, it is valid only for an ideal mixture. This requires that the heat of solution be zero and means that the range of its application is extremely limited.

Entropies of mixtures may be calculated by an expression analogous to Eq. (8), with the exception that the entropy of mixing must be taken into account. The mixing term is calculated with Eq. (3) and the total entropy of the mixture is evaluated from:

$$S_m = \Sigma z_i S_i - R \Sigma z_i \ln z_i \quad (9)$$

The limitations applicable to Eq. (8) also apply to Eq. (9).

As we have already discussed, the range of temperature and pressure conditions under which Eqs. (8) and (9) may be used is quite limited. The applicability of these equations is limited still further by the fact that it's not always possible to obtain enthalpy and entropy data on the pure compounds for the conditions of temperature and pressure under which the mixture exists.

For example, in a liquid mixture the lighter components may not exist as pure liquids under the prevailing conditions. Similarly, in the case of a gas mixture the heavier components of the mixture may not exist in the gas phase as pure components. These situations are encountered in the calculation of the thermodynamic properties of saturated mixtures. It's apparent that Eqs. (8) and (9) have severe theoretical and practical restrictions.

Equivalent-Component Method—In view of the shortcomings of simply combining the thermodynamic properties of the pure components to obtain the properties of mixtures, other methods have been advanced. In 1945 Scheibel and Jenny[12] presented an equivalent-pure-component method which is based on the assumption that a mixture and a pure component of the same molecular weight exhibit the same properties.

Scheibel and Jenny presented nomographs by which the enthalpy of a hydrocarbon mixture at any given temperature and pressure could be estimated if the molecular weight is known. In order to construct nomographs of this type, a plot of enthalpy vs. temperature with parameters of molecular weight must be made.

Nomenclature

C_p	Heat capacity at constant pressure, Btu./lb. mole-°F.
d	Density, lb. moles/cu. ft.
H	Enthalpy, Btu./lb. mole
H	Partial enthalpy, Btu./lb. mole
P	Absolute pressure, psia.
R	Universal gas constant, 1.987 Btu./lb. mole-°R.
T	Absolute temperature, °R.
V	Volume, cu. ft./lb. mole
v	Partial volume, cu. ft./lb. mole
y	Mole fraction in the vapor phase
z	Mole fraction in the liquid or vapor phase

Subscripts

c	Critical property
i	A component
m	Of the mixture
$ref.$	At the reference state

Superscripts

o	Refers to a property in the ideal-gas state

Since only one pressure can be considered on a given plot, a series of diagrams must be built to cover a range of pressures. The data on these plots are then cross-plotted—enthalpy vs. molecular weight at constant temperature and constant pressure—and from this information nomographs can be constructed for both liquid and vapor phases.

Equivalent-Component Method for Partial Enthalpies—Canjar and Peterka[4] used the equivalent-pure-component method in a slightly different manner. They applied it to the prediction of partial enthalpies.

Also, they used the molal average boiling point rather than the molecular weight as their basis. Both liquid- and vapor-phase partial enthalpy values were presented. The underlying idea of these two equivalent-component methods are the same.

Canjar and Peterka compared their results with those obtained by Sage and Lacey[11] for the systems methane-ethane and methane-*n*-pentane. In the former case the agreement with experimental data was good, but in the latter case, rather poor.

Equivalent Components with Property Charts — Another possible way of using the equivalent-component method is through the use of Kay's pseudo-critical concept[8] and the generalized thermodynamic property charts of Lydersen, Greenkorn and Hougen.[9] In this method the pseudo-critical properties are estimated by these relationships:

$$T_{cm} = \Sigma y_i T_{ci} \quad (10)$$

$$P_{cm} = \Sigma y_i P_{ci} \quad (11)$$

The computations then follow the same course as used for pure compounds. The method was originally presented by Hougen and Watson.[7] It's reasonably easy to use, provided that the composition is not a variable. However, if heat balances are required around each plate of a distillation column (where compositions change), the number of calculations involved would be very large since enthalpy vs. temperature plots for a great number of compositions would be required.

Accuracy of this method is limited by two factors. One, the inability of Eqs. (10) and (11) to predict the correct pseudo-critical properties; and two, the inaccuracy involved in using generalized thermodynamic charts.

Partial Enthalpies—The two most recent attempts to calculate accurate partial-enthalpy data have been those by Papadopoulos, Pigford and Friend[10] and Edmister and Canjar.[6] In both cases the partial enthalpy was defined as the difference between the enthalpy of the substance in the ideal-gas state and the enthalpy of the substance at the same temperature and the system pressure. To determine the total enthalpy of a mixture by this method, first obtain the enthalpy of the mixture in the ideal-gas state. Enthalpy data are available in this form for a great number of hydrocarbons in API 44.[1]

The enthalpy of the mixture is calculated by using Eq. (1a). Next step is to determine the partial-enthalpy value for each component. The sum of the enthalpy of the mixture in the ideal-gas state and the partial-enthalpy values of all the components involved is the total enthalpy of the mixture.

Papadopoulos, et al., differentiated a form of the Benedict equation to obtain their partial enthalpies, while Edmister and Canjar differentiated graphically a plot of ln (f/x) vs. T to obtain their values. The fugacity data were originally obtained through the use of the Benedict equation. Both groups of investigators reported partial enthalpy data for a number of light hydrocarbons as functions of pressure, temperature, and used the molal average boiling point as an additional correlating parameter.

There are differences between the two sets of data which are as yet unexplained.

In general, the Benedict-Webb-Rubin equation cannot be expected to represent accurately the volumetric behavior of mixtures if the molecules of the compounds are dissimilar chemically. For example, in order to make the equation reflect the volumetric behavior of gaseous mixtures of nitrogen and methane, Bloomer, Eakin, et al.[3] altered the method by which one of the empirical constants was determined. Cullen and Kobe[5] found that the equation of state did not predict accurately the vapor-liquid equilibrium data of the propane-carbon dioxide system. Both of these binary systems contained a hydrocarbon and a nonhydrocarbon compound.

However, it's also reasonable to assume that the Benedict-Webb-Rubin equation could not be used with confidence for hydrocarbon-hydrocarbon systems, if the two hydrocarbons are very different in nature.

It follows from the discussion above that the problem of predicting accurate partial-enthalpy data—particularly in the liquid phase—is unsolved.

What Conclusions Can We Draw?

The ability of the various methods outlined above to predict the thermodynamic properties of mixtures depends upon the conditions of temperature and pressure. At moderate pressures and high temperature, the thermodynamic properties of gas mixtures can be obtained with a reasonable degree of accuracy by a weighted summation of pure-component properties. The equivalent-component methods are definite improvements over the assumption of the existence of an ideal solution.

On the other hand, when conditions are extreme and there are many complicating factors such as chemical interactions, none of the methods given can be expected to predict accurate results.

Results obtained from some of the methods outlined above have been compared with results obtained through the application of rigorous thermodynamic relationships by Stiehl, Hobson and Weber.[13]

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"Basic Principles of Pneumatic Control Mechanisms," W. G. Holzbock, *Air Cond., Heating and Ventilating*, Jan. 1955, pp. 101-110.
The action of basic mechanisms in pneumatic controlling devices for regulation of temperature, pressure and flow is described; refinements in instrument design and the application of feed back principles are illustrated.

"Which Should it Be—Electric or Pneumatic Controls?," S. D. Ross, *Industry and Power*, Nov. 1954, pp. 72-75.
Proper use of electric and pneumatic automatic controls; tabular comparison of automatic control characteristics, pneumatic vs. electric.

* For author biography see *Chem. Eng.*, Sept. 1957, p. 341.

"F & P Differential Pressure Flow Meter Handbook," Fischer and Porter Co., *Catalogue 10-B-90*, Dec. 1953.
Orifice sizing procedures for static and kinetic manometers; primary and secondary elements.

"Instrumentation Handbook," *Pet. Refiner*, Dec. 1952.
"Flow Measurement and Control," L. K. Spink, pp. 98-104.
Types of controllers; types of rate meters; variable head meter; differential inducing devices; variable area meters; equipment selection.
"Temperature Measurement and Control," R. L. Nichols, pp. 104-107.
Types of measuring devices; thermal systems; thermometers; thermocouples; pyrometers.
"Pressure Measurement and Control," Hart, Porter, and R. C. King, pp. 107-111.
Types of elements; types of controllers; recorders and indicators; pilot operated controls; design considerations.
"Liquid Level Measurement and Control," E. D. Mattix, pp. 111-115.
Types and basic principles of operation; level controllers; comparative costs; maintenance problems.
"Control Valve Design and Use," D. E. Hostedler, pp. 116-120.
Materials of construction; auxiliaries; valve sizing; valve characteristics; emergency and safety considerations; installation; maintenance; economics; design.
"New Developments in Automatic Control," J. F. Draffen, pp. 121-125.
Continuous analyzers; control equipment; computers; automatic control.
"What is Good Instrumentation Worth," G. W. Wilson, pp. 126-129.
Liquid level control; pressure control; quality measurement; temperature and flow control.

"Automatic Chemical Process Control," Minneapolis Honeywell Co., *Bulletin No. CH-M-3*, 1952.
Temperature control; pneumatic transmission; pressure control; differential pressure control; specific gravity; automatic shutdown systems; heat exchangers and vaporizers; equipment controls; corrosion problems; centralized control; data segregation.

"Industrial Time Controls," R. H. Mecklenborg, *Product Eng.*, Feb. 1949, pp. 125-129.
Process factors and mechanical requirements that determine method of starting a time control on its cycle and type of cycle operation; reset and nonreset features; means of adjustment; enclosures, and general construction arrangements obtainable in standard time controls are defined and discussed.

Pneumatic and Electrical Instruments

"Thermocouples," R. I. Betzenhowser, *Plant Eng.*, March 1956, pp. 116-119.
Types; temperature limits; applications; selection; positioning; types of environment vs. material of tube.

"More for Your Instrument Dollar," C. G. Wyder, *Factory Management and Maintenance*, Nov. 1955, pp. 106-109.
Selection and training; preventive maintenance; spare parts; regular meetings; check sheets; a review of the Dow Chemical instrument control system.

"4 Questions About Control Timers," J. E. Graham, *Control Eng.*, Aug. 1955, pp. 65-70.
Types; application; selection; timer component parts are listed by function; characteristics and typical diagrams are included.

"Why Electronic Process Control?," D. M. Boyd, *Pet. Refiner*, Jan. 1955, pp. 155-158.
Graphic panels; electronic controllers; means of valve actuation; advantages of electronic controllers.

"Room Thermostats and Their Applications," W. G. Holzbock, *Heating and Ventilating*, May 1953, pp. 95-105.
Operating principles and typical examples of available equipment are set forth in a survey of temperature controlling devices. Bimetallic elements; snap action accelerators; sealed bellows; types of thermostats and their circuits; air operated thermostats.

"Liquid Level Indicators and Controllers," H. W. Hamm, *Product Eng.*, March 1952, pp. 140-141.
A graphic and pictorial presentation of thirteen different systems of operation are shown.

"Electronic Instruments and Controls," Steiner, Kalman, and W. G. Carter, *Heating, Piping and Air Cond.*, July 1951, pp. 96-99.
A brief and clear explanation of some of the electronic fundamentals used in heating, piping and air conditioning work. Vacuum tubes; photoelectric tubes; uses; electronic safety devices.

"Electrical Fundamentals and Their Use in Instruments and Control," Kalman Steiner, *Heating, Piping and Air Cond.*, May 1951, pp. 82-85.
Basic principles of electricity and electrical circuits as applied to instruments and controls; wheatstone bridge; potentiometer; thermal conductivity meter.

"Liquid Level Measurement in Chemical Processing," S. D. Ross, *Chem. Ind.*, June 1948, pp. 924-928.
Head measuring systems; pressure gauge methods; remote transmission; displacement type; electrode or probe systems; gamma ray systems.

Flow Measurement

"Primary Flowmetering Elements . . . How They Work, Where They're Used," M. R. Skrokov, *Power*, Feb. 1956, pp. 100-103.
Comparison of types; orifice design; flow nozzles; pitot tubes; elbow taps.

"Instruments for Measuring Air Flow and Metering Air," K. J. Caplan, *Heating and Ventilating*, Nov. 1954, pp. 89-100.
Practical selection and use of instruments; air flow in unconfined space; air flow in confined space; pitot tube; velocity vs. velocity pressure; anemometers; heat-flow anemometers; orifice meters; flow nozzles; venturi meters; wet-gas meters; dry-gas meters; variable orifice meters; permanent meters for large flow; characteristics of air velocity and air flow meters.

"Metering of Powdered Solids in Gas-Solids Mixtures," Leonard Farbar, *Ind. and Eng. Chem.*, Dec. 1952, pp. 2947-2955.
Description of system, material, and metering nozzles; experimental procedure; resulting data.

"Convenient Flowmeter Conversions," D. P. Huron, *Chem. Eng.*, March 1952, pp. 142-143.
The article demonstrates in text and graphs the feasibility of calibrating any flowmeter with the most convenient fluid at hand, and of converting the calibration so obtained to any other fluid without loss of accuracy.

"Calibration of Rotameters," J. J. Martin, *Chem. Eng. Progress*, May 1949, pp. 338-342.
Calibration curves for a two-inch rotameter; results of test calibration runs; development of rotameter calibration.

"The Why and How of Flowmeter Seals," C. S. Beard, *Power*, April 1949, pp. 82-84.
Sealing fluids for measuring elements of differential flowmeters; remote metering; selection of sealing fluid; flowing seals; injection point; piping considerations; operation.

Control Valves

"Why Not Try Simplicity in Valve Controls?," C. S. Beard, *Ind. and Power*, Feb. 1956, pp. 54-57.
How to select optimum control; regulator is a pri-

mary control; throttling control; which controller action to use; set points; pilot systems; characterized valves.

"Here's Your Air-Operated Diaphragm Controlled Valve," Steve Elonka, *Power*, Oct. 1955, pp. 118-119.
How the valve works; applications with graphic circuit diagrams.

"Selecting Control Valve Trim for High Pressure Drop and Erosive Service," Paul Wing, Jr., *ISA, Journal*, Sept. 1955, pp. 332-337.
Factors which determine the need for erosion resistant trim and available materials of construction; principal valve types; type of service; materials of construction.

"Effect of Operator on Control Valve Characteristics," J. B. Mason, Conoflow Corp. *Paper No. 54-17-3*, 1954.
Characterized valve plugs; stem friction; effective diaphragm area; cylinder operator; final control elements.

"Special Report to Industry—Control Valves and Positioners," C. S. Beard, *Ind. and Power*, March 1953, pp. 67-106.
Flow characteristics; valve body design; valve types; mechanical features of valve body; electrical actuation; measurement of variables; viscosity of flowing fluids; corrosion resistance data.

"Sizing Control Valves," R. A. Rockwell, *Heating, Piping and Air Cond.*, Nov. 1952, pp. 98-99.
Use of the valve flow coefficient for sizing control valves.

"Selecting a Control Valve," John Procopi, *Heating, Piping and Air Cond.*, Aug. 1950, pp. 96-99.
Power units for control valves; body members; inner valves and flow characteristics, materials for various services; effect of valve size.

Flow Proportioning

"Liquid Proportioning," Lawrence Lowy, *Chem. Eng.*, May 1956, pp. 175-188.
Batch vs. continuous; feeders vs. meters; types of volumetric meters; types of feeders; gravimetric devices; methods of control; actuating mechanism.

Process Control

"Chemical Process Instrumentation in Transition," L. E. Slater, *Chem. Eng.*, June 1957, pp. 251-258.
The whole picture of process instrumentation, where we are, where we're headed, what's ahead and how we're going about getting there.

"Controllers and Final Control Elements," W. G. Holzbock, *Chem. Eng.*, June 1957, pp. 259-262.
Advances in controllers and valves; electronic vs. pneumatic.

"Where primary Elements Are Headed," T. R. Olive, *Chem. Eng.*, June 1957, pp. 263-265.
Trends in detecting and measuring variables; temperature, pressure, liquid and solids level, fluid flow; needs for the future.

"Process Control by Analytical Instrumentation," A. R. Aikman, *Chem. Eng.*, June 1957, pp. 266-273.
How analytical instruments are used for process control; thermal catalytic conversion; flow calorimeters; thermal conductivity; moisture in gases; sonic methods; ionizing radiation; refractive index; mass spectrometry; vapor chromatography; radio-frequency spectroscopy; X-ray spectroscopy; ultraviolet spectroscopy; nucleonic techniques.

"Data Handling Systems," T. R. Vick Roy, *Chem. Eng.*, June 1957, pp. 274-279.
Data logging and where the new technique fits in; data-handling systems; cost of data loggers; future prospects; reliability.

"Computers in Process Control," Arthur Freilich, *Chem. Eng.*, June 1957, pp. 280-284.
What steps will lead us to computer control; use of digital data loggers; process supervision by computers; dynamic control with computers.

"Control by Automatic Experimentation," Robert Hooke, *Chem. Eng.*, June 1957, pp. 284-286.
Development of computer-controllers which experiment with various settings of the controller. Faster and more accurate than a plant operator in order to optimize control.

Miscellaneous

"Industrial Instrument Maintenance," T. M. Gayle, *Plant Eng.*, April 1956, pp. 132-136.
Effects of environment; installation; pneumatic instruments.

"Instrumentation Planning Procedures," C. S. Beard, *Plant Eng.*, Feb. 1956, pp. 92-96, 198, 200.
Process flow diagram; instrument designations and abbreviations based upon their functions; designations and symbols; test points; controller systems; panel boards.

"Pneumatic Time-Delay Relays," Carl Lindahl, *Product Eng.*, Jan. 1956, pp. 174-177.
Relay function; how pneumatic time-delay relays operate; performance characteristics; contact arrangements for standard and nonstandard relays; typical applications.

"Combustion Safeguard Systems," Conrad Cleason, *Gas*, July 1955, pp. 62-66.
Mechanical and electronic devices available for domestic and industrial fields; electrodes; flame rectification; infrared radiation.

"How Many Operating Variables Can You Control?," M. G. Larian, *Pet. Refiner*, Sept. 1953, pp. 219-223.
Basic ideas; equilibrium stage in flow contactor; multistage contactor; effect of control of variables; optimum number of variables controlling.

"What You Need to Know About Electronic Controls," Norman Weissman, *Factory Management and Maintenance*, Sept. 1953, pp. 118-127.
Application; selection; costs; maintenance; specification.

"Automatic Control Terms, Parts I-V," D. P. Eckman, *Chem. Ind.*, May-Oct. 1946.
Part I, May 1946, p. 832.
Definition and circuits: automatic controllers and control systems.
Part II, June 1946, p. 1020.
Terminology continued: basic characteristics.
Part III, July 1946, pp. 120-122.
Terminology continued: characteristics of automatic control.
Part IV, Sept. 1946, p. 528.
Terminology continued: adjustments of automatic controller action.
Part V, Oct. 1946, p. 710.
Terminology continued: specifying automatic controllers.

"Automatic Control, Its Fundamentals," D. P. Eckman, *Chem. Ind.*, April 1945, pp. 590-593.
Proportional control; reset response; process characteristics: location of detecting elements; time lag and its effect on controls.

Refrigeration

Selection

"Refrigeration," Tyler Hicks, *Power*, Oct. 1955, pp. 76-94.
Simplified approach; selection; well illustrated; con-

densed facts on systems and their components; compressors; evaporators; condensers; controls; piping; brines and refrigerants; current practices in equipment selection and operation; application of various refrigerants available for optimum results; physical properties, pressure-enthalpy data on refrigerants; tonnage capacities of Freon piping.

"Various Methods for Using Evaporative Condensers," J. R. Harnish, *Air Cond., Heating and Ventilating*, July 1955, pp. 84-92.
There are many ways that this type of condenser can be used in air conditioning or refrigeration systems—single, in multiple, or in combination with a shell and tube condenser. These systems are described and the many piping arrangements illustrated.

"Evaporative Condensers in Freon-12 Refrigerating Systems," O. B. Wert, *Air Cond., Heating and Ventilating*, April 1955, pp. 85-89.
How to install evaporative condensers in refrigerating systems using Freon-12, and where to place the various components that are part of the evaporative condenser in order to obtain the best results. Information is included on the use of several condensers, either of the same, or of different types; maintenance.

"Shell and Tube Condensers in a Refrigerating System," O. B. Wert, *Heating & Ventilating*, Oct. 1954, pp. 100-106.
Physical characteristics of refrigerants; heat transfer data; evaluation for U; graphical curves for solving condenser performance in heat rejection vs. gpm. of cooling water.

"Refrigeration and Refrigerants," C. L. Rescorla, *Chem. Eng.*, June 1953, pp. 200-207.
Typical refrigeration applications in the chemical process industries; vapor compression systems; characteristics and application range of industrial refrigerants; compound vapor compression; air expansion system; absorption refrigeration; steam-jet refrigeration; heat pump; compressors; condensers and evaporators; some cost data.

"Lower Temperatures; New Cycles Benefit Refrigeration Users," D. L. Fiske, *Chem. Eng.*, May 1950, pp. 136-139.
New refrigerants; improved compressors; better insulation; interesting new cycles; graphical, relative capacity and power requirements vs. condensing and low evaporator temperatures; coefficient of performance vs. condensing and evaporation temperatures; vapor pressure curves for a number of refrigerants; process applications.

"Selecting Chilled Water Coils," J. A. Bishop, *Heating, Piping and Air Cond.*, Sept. 1948, pp. 83-87.
Use of psychometric charts in refrigeration problems; guide to a method that will allow (on the acceptance of certain assumptions) setting up the components of coil duty and assure the coil matching the duty, without tedious trial and error calculations; choosing water temperature; effect of coil selection on operation.

"Suction Line Heat Exchangers," H. E. Ferrill, *Heating, Piping and Air Cond.*, June 1948, pp. 90-93.
Use of pressure-enthalpy diagrams in refrigeration design; compressor loading; flash gas and its effect on design; operation of suction line heat exchangers; heat exchangers and coil performance.

Design

"How to Size an Unloading Compressor," E. L. Ghormley, *Pet. Refiner*, May 1956, pp. 211-212.
A rapid method of sizing a gas unloading compressor; establishes the maximum horsepower required to discharge the contents of a gas tank car within a given time. Method applicable to design of vacuum compressors.

"Simplify Gas Cooling Tower Design," G. H. P. Bras, *Pet. Refiner*, March 1956, pp. 191-195.
A simplification of the enthalpy method to speed up design calculations; graphical solution; analytical solution; comparison with temperature-vapor pressure method.

"Planning Refrigeration Plant Piping Systems," C. T. Baker, *Ind. and Power*, March 1955, pp. 48-50.
Suction line losses; friction in fittings; installation procedures; supporting the piping; flanges.

"Vibration and Noise in Refrigerant Pipe Lines," E. T. Neubauer, *Air Cond., Heating and Ventilating*, March 1955, pp. 88-89.
General discussion of the problem; impulse frequency; correction for amplification.

"Better Refrigerant Piping for Parallel Compressor Systems," L. R. Scafe, *Heating, Piping, and Air Cond.*, March 1955, pp. 124-128.
How to arrange compressors in parallel; effect of physical location; water-cooled condenser; how capacity modulation affects piping arrangement; how to avoid lubrication failures; evaporative condensers; duplex compressor units.

"P-V-T Relationships for Freon-11," R. L. Brehm, *Chem. Processing*, Feb. 1955, p. 210.
Nomographic form.

"Refrigeration Questions and Answers; Special Control Valves for Your System," Tyler Hicks, *Power*, Sept. 1953, pp. 118-119.
Selection of right unit to avoid many common troubles, simplify plant operation and maintenance.

"Charts for Refrigeration Design," L. J. Murphy, *Heating and Ventilating*, June 1953, pp. 87-88.
Nomographical solutions to formulae for discharge capacity of refrigeration systems; safety codes ASRE standard.

"Suction Gas Superheaters for Freon-12 Systems," *Heating and Ventilating*, April 1953, pp. 127-128.
Graphical solution to length of double pipe superheaters for special installations.

"Suction Gas Superheaters for Freon-12 Systems," *Heating and Ventilating*, March 1953, pp. 82-84.
Discusses the use of suction gas superheaters for improving refrigerating effect. Graphs are presented to show how to select superheaters of double pipe and shell coil types.

"Piping Tips for Smart Running Small Refrigeration Systems," *Power*, Oct. 1952, pp. 112-113.
Sizing, arrangement and physical location of components for trouble-free performance.

"Right Refrigerant Piping," Leegard, C. W., and W. E. Dodson, *Heating, Piping and Air Cond.*, Aug. 1952, pp. 98-101.
The relation between poor piping practices and compressor failure; flash gas reduction of capacity; design of hot gas lines; suction line design; oil separators.

"Cooling Water for Ammonia Condensation," J. F. Hyam, *Power*, Oct. 1949, p. 134.
Alignment chart to calculate cooling water flow required to condense ammonia in a refrigerating system.

"Heat Transfer Rates for Refrigerant Boiling in Horizontal Tube Evaporators," Seigel, L., W. Bryan, and M. Huppert, *Ice and Refrigeration*, Feb. 1949, pp. 21-23.
Heat transfer rates for Freon-12 boiling inside smooth horizontal tube evaporators; correlation of heat transfer between Freon and tube wall in terms of weight flow of Freon, and surface area of the evaporator; effects of evaporator pressure, percentage of flash gas, and L/D ratio.

"Pressure Drop in Refrigerant Lines," G. R. King, *Ice and Refrigeration*, Feb. 1949, pp. 41-44.

Graphical charts for finding pressure drops in refrigerant lines carrying ammonia, Freon-12 and Freon-22; relation between pressure drop and velocity.

Maintenance and Operation

"Pulling Vacuum and Charging Refrigeration Systems," *Power*, June 1956, pp. 120-121, 200-202.
Stepwise procedure for pulling vacuum and charging system; check list for checking out the system before startup.

"Halt Your Losses in Refrigeration Condensers," A. John, *Ind. and Power*, April 1956, pp. 39-41.
Economics of head pressure increase; calculation of heat required.

"Install and Maintain Your Refrigerant Expansion Valves Right," Charles Thielmann, *Power*, Jan. 1956, p. 124.
Selection; installation; adjustment; maintenance.

"Check-out Your Refrigerating Unit When It's New," *Power*, Nov. 1953, pp. 120-121.
A quick rundown on check points for operation of a refrigeration system.

"Refrigeration Controls—Their Characteristics and Operation," *Plant Eng.*, Jan. 1953, pp. 104-110.
Refrigerant (liquid and vapor) controls; motor controls; high and low pressure controls; low temperature controls; oil pressure differential controls; hot-gas evaporator defrosting; time-pressure defrosting; temperature or pressure rise alarms; cooling-water flow regulation; solenoid valves.

"Charts to Check Operation of Refrigeration Plants," J. M. Morse, *Heating and Ventilating*, May 1952, pp. 79-80.
Graphical means of solving for tons of refrigeration being produced by a system in operation.

"Control of Discharge Pressures Prevents Refrigeration Troubles," H. A. Blair, *Heating and Ventilating*, Nov. 1951, pp. 61-67.
Various methods of control to maintain system stability; control of discharge pressure fluctuation; reduced head pressure; influence on oil return; modulating spray nozzles supply; control through air circuit; cooling towers.

Refrigerants

"Thermodynamic Properties of Freon-12," E. I. duPont deNemours and Co., 1955.
Complete tables and Mollier diagram.

"Freon Compounds," E. I. duPont deNemours and Co., *Kinetic Technical Bulletin—B-2*, 1954.
Chemical properties; physiological action; applications; chart of pressure temperature relationships; chart of physical properties.

"Pressure-Volume-Temperature Properties of the Freon Compounds," B. J. Eiseman, Jr., *Refrigerating Eng.*, May 1952, pp. 496-503.
Physical data; orthobaric densities; vapor pressure curves; critical pressures; reduced properties of Freon compounds; applications.

"Effect on Elastomers of Freon Compounds and Other Halohydrocarbons," B. J. Eiseman, Jr., *Refrigerating Eng.*, Dec. 1949, pp. 1171-1174.
Table: swelling of elastomers in halohydrocarbons; effect of oil at room temperature; swelling in substituted methanes; elastomer content of vulcanized compounds; extraction of elastomers by halohydrocarbons.

"Low Temperature Freon Refrigerants," D. L. Fiske, *Refrigerating Eng.*, April 1949, pp. 336-339.
Freon-13 and Freon-14; applications; pressure-enthalpy diagrams; thermodynamic properties.

"Thermodynamic Properties of Freon-22," Graham, D. P., and R. C. McHarness, Jr., E. I. duPont deNemours and Co., 1945.
Complete tables.

"Thermal Conductances and Heat Transmission Coefficients of Freon Refrigerants," Benning, A. F., and R. C. McHarness, Jr., E. I. duPont deNemours and Co., 1942.
Thermal conductivity; heat transmission coefficients; vapor coefficients; condensing films; liquid films for turbulant and streamline flow.

"Thermodynamic Properties of Freon-11 At Low Pressures," Benning, A. F., and W. H. Markwood, Jr., E. I. duPont deNemours and Co., 1942.
Complete tables for low pressures.

"Design Factors When Using Freon-12," R. L. Williams, E. I. duPont deNemours and Co., *Kinetic Technical Bulletin RT-11*.
Comparative data on Freons; compressor vapor displacement; amount of refrigerant to be evaporated; head pressures; back pressures; lubrication; filters and strainers; materials of construction; leak detection; diagnosing troubles; drying units.

Illumination

Standards

"American Standard Practice for Industrial Lighting," American Standards Association, *A11.1*, 1952.
ASA specifications; factors affecting seeing tasks; factors of good illumination; influence of environmental factors; daylighting; artificial lighting; general lighting; supplementary lighting; maintenance; brightness and brightness ratios.

Selection and Application

"Industrial Lighting," O'Connor, J. J., and Norman Peach, *Power*, June 1952, pp. 73-96.
A summary of concepts; fundamentals; light measurement; lighting practice; efficiency, brightness and heat; auxilliaries; types; planning a system; a complete system of calculation; supplementary lighting; light source selection guide; quality of light; illumination levels; emergency lighting; maintenance.

"A Guide to Lighting Installations," Crouse-Hinds Company, *Bulletin 2688*, Jan. 7, 1956.
Recommended levels of illumination; reflection factor; maintenance factor; room index; coefficients of utilization; fixture location; step by step calculations.

Design

"Procurement and Inventory of Industrial Electric Lamps," L. V. James, *Plant Eng.*, Dec. 1953, pp. 90-92.
Lamp types; cost; operational costs.

"Protective Lighting for Industrial Plants," L. V. James, *Plant Eng.*, Nov. 1953, pp. 115-118.
Types and arrangements.

"Visual Inspection—Other Lighting Applications," L. V. James, *Plant Eng.*, Oct. 1953, pp. 111-114.
Surface flow detection, color matching; checking of welds.

"Maintenance Costs of Industrial Lighting Systems," L. V. James, *Plant Eng.*, Aug. 1953, pp. 89-92.
Cleaning expenses; application of maintenance factor; mortality curve for fluorescent lamps; coefficients of utilization.

"Economic Factors in Industrial Lighting," L. V. James, *Plant Eng.*, July 1953, pp. 93-96.
Benefits of lighting and effect on production; cleaning cost; lamp replacement; fixed charges; operating charges; lamp replacement.

"Significant Factors in Illumination Design," L. V. James, *Plant Eng.*, June 1953, pp. 105-108.
Spacing; direction of light; ceiling and wall reflection factors; maintenance factors.

"Mercury Lamps—Characteristics and Applications," L. V. James, *Plant Eng.*, May 1952, pp. 122-124.
Lamp characteristics; applications.

"Incandescent Lamps—Their Industrial Applications," L. V. James, *Plant Eng.*, April 1953, pp. 104-110.
Carbon and metal filaments; efficiencies; filament research; blackening effects; shapes; refector types.

"Fluorescent Lamps, Application—Characteristics," L. V. James, *Plant Eng.*, March 1953, pp. 90-93.
Luminous efficiencies; lamp bases and holders; types of fixtures; color of light; group replacement.

"Artificial Lighting and its Relation to Air Conditioning," Walter Sturrack, *Heating and Ventilating*, Jan. 1953, pp. 101-112.
Data on recommended lighting levels for various kinds of work and interiors; a discussion of temperature rise from lighting as related to design; data and stepwise calculations for design of a lighting system; room index; mounting height.

"How to Compute Illumination Distribution," *Eng. News-Record*, May 3, 1951, pp. 42-44.
Variation of exterior illumination with time of day; performance factors for sky light; nomographic solution for illumination distribution; sun azimuth corrections; example cases.

Structural

General

"Plastics for Structural Use," *Product Eng.*, June 1956, pp. 167-182.
New development in materials, processing technique and methods of lubrication; classification of plastics in terms of design requirements; chemical resistance, mechanical properties; dimensional stability; production methods; laminates; reinforced plastics; fabrication methods; costs.

"Designing Composite Members," R. J. Auman, *Product Eng.*, June 1956, pp. 140-143.
Stress and deflection formulas for members made of materials with different elastic modulus values; graphical solution for composite members of unequal length or homogeneous members of varying cross section.

"Construction Briefs—a Review of Fundamentals for the Plant Engineer," Plant Eng., July 1953-June 1956.
A series on structural formulas.

Soil Engineering

"Fundamentals of Soils Engineering," R. H. Karol, *Pet. Refiner*, Aug. 1955, pp. 143-149.
A thorough treatment of the subject of the action of soil under the loads imposed by foundations; bearing capacity; settling; sliding; overturning.

"Soil Pressure Under Foundations," R. W. Osburn, *Pet. Refiner*, Dec. 1949, pp. 123-124.
Basic introduction; calculation of eccentricity; allowable eccentricities; graphical solution for eccentricity.

Foundations for Stills and Towers

"Foundations for Self-Supporting Towers," E. G. Jackson, *Pet. Refiner*, June 1954, pp. 145-147.
Practical, workable solutions to foundation design problems; stability; anchor bolts; bolt circle.

"What Size Foundation for Your Stills and Towers?," A. A. Brown, *Chem. Eng.*, Oct. 1952, pp. 136-137.
Simplified method for determining foundation size for stills and towers; maximum soil pressure.

Foundations for Stacks

"Simplified Foundations for Stacks and Towers," W. B. Summer, *Pet. Refiner*, July 1954, pp. 141-148.
Method for a one-computation solution of bending moments and shears for various forms of loading; wind loading; static loading; soil loading; stability; foundation bolts; reinforcing; design; graphical solutions; examples.

"Graphical Methods Aid in Stack Foundation Design," C. H. Fork, *Pet. Refiner*, Mar. 1951, pp. 81-85.
Graphical methods that eliminate much of the trial and error procedure in the design of foundations for self-supporting stacks and towers. Example worked out.

Rectangular Footings

"Design of Rectangular Footings," C. H. Fork, *Pet. Refiner*, Feb. 1953, pp. 110-111.
By this method one set of equations is made to apply to both axis of the footing.

"Applying Graphical Methods to Square Footing Designs," C. H. Fork, *Pet. Refiner*, Nov. 1952, pp. 145-149.
A method which eliminates much of the trial and error procedure in the design of stack and tower foundations; overturning; graphical aids; examples.

Supports for Vertical Vessels

"Supports for Vertical Pressure Vessels, Parts I-IV," F. E. Wolosewick, *Pet. Refiner*, July-Dec. 1951.
Part I, July 1951, pp. 137-140.
Column supports; ring supports; lug supports; skirt supports; lug reactions.
Part II, Aug. 1951, pp. 101-108.
Basic considerations; development of general equations; vessel reinforcement; hoop stresses due to lug action; temperature gradient in lugs; forces on shell due to heating and cooling; relationships of lugs to bottom of heads of vessels.
Part III, Oct. 1951, pp. 143-145.
Ring stiffeners on vessels; skirt supports; methods of absorbing expansions; temperature drop in skirts.
Part IV, Dec. 1951, pp. 151-153.
Stress in skirts due to thermal expansions; use of beam on elastic foundation; stresses in skirts from other sources.

Supports for Horizontal Tanks

"Supporting a Horizontal Tank," T. E. Bridge, *Heating, Piping and Air Cond.*, Nov. 1951, pp. 98-99.
Another method for solving the support problem given below.

"How Can I Figure Supports for a Horizontal Tank?," T. E. Bridge, *Heating, Piping and Air Cond.*, June 1951, pp. 88-89.
Horizontal tank supports based on formula for support of a large thin wall pipe. Example calculated.

Base Plate Design

"Graphic Statics Solve Base Plate Design," Feinnman, G. P., and J. P. O'Donnell, *Pet. Refiner*, July 1954, pp. 149-153.
Design of base plates and anchor bolts for stacks, towers, and columns; basic theory; illustrative example.

Anchor Bolt Problems

"Nomograms for the Solution of Anchor Bolt Problems," A. I. Gartner, *Pet. Refiner*, July 1951, pp. 101-106.
Article presents two nomograms which facilitate the design and investigation of anchor bolts for tall towers and stacks; a number of examples are given.

SHAFT STRAIGHTENER This 50-ton press straightens a LIGHTNIN Mixer shaft to tolerances as fine as .002"—so it will be running true 10 or 20 years from now.

How to prevent **shaft failure** *when you mix fluids mechanically*

An out-of-line shaft on a mechanical mixer can be bad for your process, in more ways than one.

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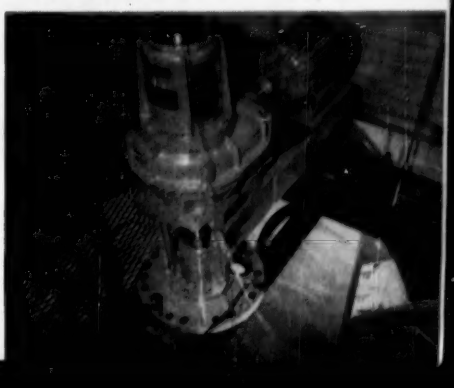

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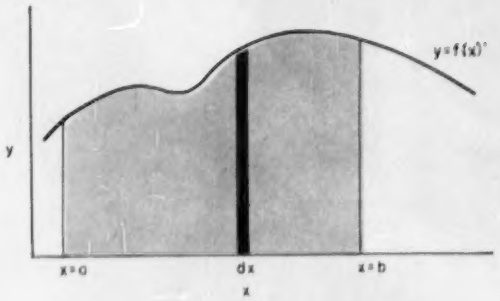

When experimental data must be analyzed, use the numerical methods described here for rapid and accurate calculations. Solved problems help you understand the uses and limitations of these techniques.

WHERE ANALYTICAL METHODS WON'T WORK

Use Numerical Integration and Differentiation

WILLIAM E. BALL, Washington University, St. Louis, Mo.*
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This month we continue our study of evaluating integrals by approximate methods. In last month's discussion (*Chem. Eng.*, Nov. 1957, p. 272), we showed how graphs and graphical methods of integration and differentiation can be used. We now proceed with techniques in numerical methods.

How to Use Numerical Integration

Often it is easier to perform an integration numerically since then there is no need for the drawing of a graph. Also, the addition of a series of numbers is faster than most square-counting processes.

Consider the functional relationship $y = f(x)$. Use the symbol x_i to indicate a particular value of the variable x. The corresponding value of y is found from the functional relationship $y_i = f(x_i)$.

In general, for a numerical integration problem, consider the limits of integration to be from a to b.

$$A = \int_a^b y\,dx \qquad (1)$$

If the interval from a to b is divided into n equal parts, then let $h = (b - a)/n$. It is apparent that if the x_i values are the values of x at the end of each h interval, we will have the relationship

$$x_i = x_0 + ih \qquad (2)$$

For example: Consider the integral $\int y dx = A$ between the limits two and five. Here $a = 2$ and $b = 5$. If we arbitrarily divide the interval into three equal parts, then h equals one. Thus the x_i values from Eq. (2) are

$$x_0 = 2 + 0(1) = 2$$
$$x_1 = 2 + 1(1) = 3$$
$$x_2 = 2 + 2(1) = 4$$
$$x_3 = 2 + 3(1) = 5$$

If for each of the above x_i values, we have an experimentally determined y_i value how do we determine A? Of course, we may solve the problem by a graphical integration. However, to establish a purely numerical method for evaluating the integral, consider the nature of the function $y = f(x)$. Since we do not know what $f(x)$ actually is, let us assume that between each adjacent pair of x_i values $f(x)$ may be approximated by $f(x) = mx + c$ which is a straight line.

Then if we consider the integral over just the first interval, we have

$$A = \int_{x_0}^{x_1} y dx = \int_{x_0}^{x_1} (mx + c)\,dx$$

$$A = \frac{m}{2}(x_1 + x_0)(x_1 - x_0) + c(x_1 - x_0) \qquad (3)$$

Since $h = (x_1 - x_0)$, Eq. (3) may be written as

$$A = h/2\,[(mx_1 + c) + (mx_0 + c)]$$

But, by our original linear assumption, this is just

$$A = h/2\,(y_1 + y_0) \qquad (4)$$

This result is the trapezoidal rule.

The original integral can be split into

$$\int_a^b y dx = \int_{x_0}^{x_1} y dx + \int_{x_1}^{x_2} y dx + \ldots + \int_{x_{n-1}}^{x_n} y dx$$

$$= \frac{h}{2}(y_1 + y_0) + \frac{h}{2}(y_2 + y_1) + \ldots \frac{h}{2}(y_n + y_{n-1})$$

Hence we can say that

$$\int_a^b y dx = h\left(\frac{1}{2}y_0 + y_1 + y_2 + \ldots + y_{n-1} + \frac{1}{2}y_n\right) \qquad (5)$$

Of course, the factor influencing the accuracy of this trapezoidal rule is just how well the straight line actually fits the function between data points. This accuracy can be improved in one of two ways. The first is use more subdivisions of the integration

* For authors' biographies, see *Chem. Eng.*, Sept. 1957, pp. 343-344.

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Use These Newton-Cotes Formulas for Approximate Values of Integrals

Degree of Approximation	Formula	Interval, h
Linear	$A = \int_{x_0}^{x_1} y\,dx = \frac{h}{2}(y_0 + y_1)$	$h = \frac{x_1 - x_0}{1}$
Quadratic	$A = \int_{x_0}^{x_2} y\,dx = \frac{h}{3}(y_0 + 4y_1 + y_2)$	$h = \frac{x_2 - x_0}{2}$
Cubic	$A = \int_{x_0}^{x_3} y\,dx = \frac{3h}{8}(y_0 + 3y_1 + 3y_2 + y_3)$	$h = \frac{x_3 - x_0}{3}$
Quartic	$A = \int_{x_0}^{x_4} y\,dx = \frac{2h}{45}(7y_0 + 32y_1 + 12y_2 + 32y_3 + 7y_4)$	$h = \frac{x_4 - x_0}{4}$

Note: These formulas involve linearly equispaced ordinates only and use all of them.

interval. As h becomes smaller, the straight line approximation always becomes better. In fact as $h = \Delta x$ approaches zero, we are back to the original definition of an integral.

The second way to improve the accuracy is to assume a quadratic curve instead of a linear curve between the x_i values. We then get

$$\int_{x_0}^{x_1} y\,dx = \int_{x_0}^{x_1} (ax^2 + bx + c)\,dx$$

Integrating and substituting limits gives

$$\int_{x_0}^{x_1} y\,dx = \frac{a}{3}(x_1^3 - x_0^3) + \frac{b}{2}(x_1^2 - x_0^2) + c(x_1 - x_0)$$

We may also write the above equation as follows:

$$\int_{x_0}^{x_1} y\,dx = \frac{a}{3}(x_2^3 - x_1^3) + \frac{b}{2}(x_2^2 - x_1^2) + c(x_2 - x_1) + \frac{a}{3}(x_1^3 - x_0^3) + \frac{b}{2}(x_1^2 - x_0^2) + c(x_1 - x_0)$$

Since $h = (x_2 - x_1) = (x_1 - x_0)$, we can factor the above expression and replace the factor $(x_2 - x_1)$ or $(x_1 - x_0)$ by h. The resulting equation is

$$\int_{x_0}^{x_1} y\,dx = \frac{h}{3}\left[a(x_2^2 + x_1x_2 + x_1^2) + \frac{3b}{2}(x_2 + x_1) + 3c + a(x_1^2 + x_1x_0 + x_0^2) + \frac{3b}{2}(x_1 + x_0) + 3c\right]$$

However our original function is $y_i = ax_i^2 + bx_i + c$. Therefore

$$y_0 = ax_0^2 + bx_0 + c$$
$$y_1 = ax_1^2 + bx_1 + c$$
$$y_2 = ax_2^2 + bx_2 + c$$

Next we expand and collect the terms within the brackets of the preceding equation and substitute the values y_0, y_1 and y_2. The equation is now written

$$\int_{x_0}^{x_1} y\,dx = \frac{h}{3}(y_0 + 4y_1 + y_2) \qquad (6)$$

This is Simpson's rule. Now for more intervals, we can say

$$\int_a^b y\,dx = \int_{x_0}^{x_2} y\,dx + \int_{x_2}^{x_4} y\,dx + \ldots + \int_{x_{n-2}}^{x_n} y\,dx$$
$$= \frac{h}{3}(y_0 + 4y_1 + 2y_2 + 4y_3 + \ldots + 2y_{n-2} + 4y_{n-1} + y_n) \qquad (7)$$

Note that n must be an even number for this case.

This process may be repeated using any order of approximating polynomial desired. However, the higher order expressions are usually better adapted to high-speed automatic computation. The lower order expressions given here are better suited for hand calculation.

For reference, the expressions for the first four equations are given in the table. These expressions are referred to as Newton-Cotes formulas or closed-type quadrature formulas.

Problem 1—Evaluate by various methods the integral

$$A = \int_1^3 \left(\frac{1}{x}\right) dx$$

Use the linear, quadratic and quartic approximations of the Newton-Cotes formulas. For the linear and quadratic methods, use two intervals for h. Also find the error for each approximation when compared to the analytical solution.

Solution:

Analytic method

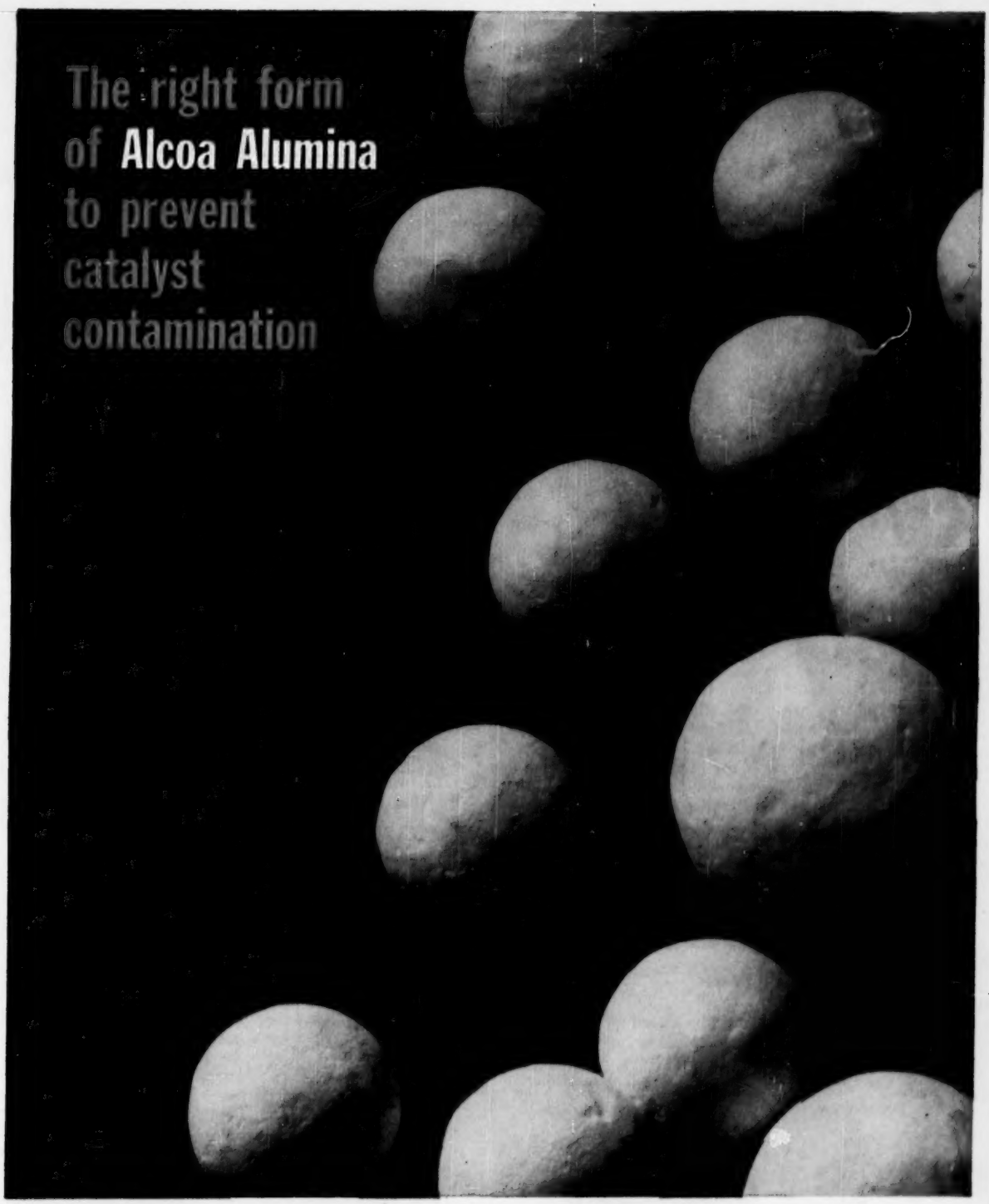
$$\int_1^3 \left(\frac{1}{x}\right) dx = \int_1^3 \log_e x = \log_e x \Big]_1^3 = 1.09861$$

Linear approximation (Trapezoidal rule) where $n = 2$ and $h = 1.0$.

$$\int_1^3 \left(\frac{1}{x}\right) dx = \frac{1.0}{2}\left[\left(\frac{1}{1}\right) + 2\left(\frac{1}{2}\right) + \left(\frac{1}{3}\right)\right] = 1.16667$$

Error = 6.20%

Linear approximation (Trapezoidal rule) where $h = 0.5$.



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Error = 1.64%

Quadratic (Simpson's rule) where $h = 1.0$.

$$\int_1^3 \left(\frac{1}{x}\right) dx = \frac{1.0}{3}\left[\left(\frac{1}{1}\right) + 4\left(\frac{1}{2.0}\right) + \left(\frac{1}{3.0}\right)\right] = 1.11111$$

Error = 1.14%

Quadratic (Simpson's rule) where $h = 0.5$.

$$\int_1^3 \left(\frac{1}{x}\right) dx = \frac{0.5}{3}\left[\left(\frac{1}{1}\right) + 4\left(\frac{1}{1.5}\right) + 2\left(\frac{1}{2.0}\right) + 4\left(\frac{1}{2.5}\right) + \left(\frac{1}{3.0}\right)\right] = 1.10000$$

Error = 0.13%

Quartic (Fourth degree approximation) if $h = 0.5$.

$$\int_1^3 \left(\frac{1}{x}\right) dx = \frac{2(0.5)}{45}\left[7\left(\frac{1}{1}\right) + 32\left(\frac{1}{1.5}\right) + 12\left(\frac{1}{2.0}\right) + 32\left(\frac{1}{2.5}\right) + 7\left(\frac{1}{3.0}\right)\right] = 1.09926$$

Error = 0.06%

Note how the increase in the number of subdivisions and the increase in the order of the approximation improve the accuracy of the results.

There are two other pertinent facts.

1. The expressions for numerical integration can be evaluated on a modern desk calculator without any pencil and paper work.

2. The example illustrates the better side of these approximations since the function $f(x) = (1/x)$ is quite well-behaved in the interval considered. Naturally, it is possible to find examples where even a quartic polynomial is not sufficient to adequately approximate the function.

Problem 2—Evaluate the integral

$$A = 10 \int_{75}^{250} \frac{c_p dt}{U\,(t_s - t)}$$

Here the integral cannot be solved analytically. For the application and graphical solution see *Chem. Eng.*, Nov. 1957, p. 272.

Use these values for the numerical solution:

Temperature, t	Value of function, $c_p/U\,(t_s - t)$
75	0.00496
100	0.00560
125	0.00643
150	0.00752
175	0.00908
200	0.01140
225	0.01525
250	0.02295

Solution:

$$A = 10\left\{\frac{25}{2}(0.00496 + 0.00560) + \frac{25}{3}[0.00560 + 4(0.00643) + 2(0.00752) + 4(0.00908) + 2(0.01140) + 4(0.01525) + 0.02295]\right\}$$

$$A = 10\,(0.132 + 1.579) = 17.1 \text{ sq. ft.}$$

Since there is an odd number of intervals between the data points, Eq. (4) was used for the first interval. Eq. (6) was then used twice to cover the remaining six intervals on the curve.

How to Use Numerical Differentiation

As when we considered numerical integration, assume that we have a set of values $y_i = f(x_i)$. We now want to evaluate dy/dx. First we write the Taylor's series representing the unknown function $f(x)$:

$$y = y_0 + y_0'(x - x_0) + \frac{1}{2!}y_0''(x - x_0)^2 + \frac{1}{3!}y_0'''(x - x_0)^3 + \ldots \quad (8)$$

where y_0^n equals the nth derivative of $f(x)$ evaluated at the point where $x = x_0$.

Note that what we want to find is the coefficient of $(x - x_0)$, the second term in the Taylor's series expansion of $f(x)$.

If we again consider equispaced values of the variable x (this is convenient but not necessary), then for $x = x_1$

$$y_1 = y_0 + y_0'(x_1 - x_0) + \frac{1}{2}y_0''(x_1 - x_0)^2 + \ldots$$

$$= y_0 + hy_0' + \frac{h^2}{2}y_0'' + \ldots \quad (9)$$

Again, as for numerical integration let us assume that the function $f(x)$ may be approximated between x_0 and x_1 by $f(x) = ax + b$. If this relationship is approximately true, then $f'(x) = a$ and $f''(x) \cong 0$. Then,

$$y_1 = y_0 + hy_0' + [(1/2)\,h^2y_0'' + \ldots]$$

The brackets indicate terms that will be neglected. Solving for y_0' gives

$$y_0' = (y_1 - y_0)/h + [-(1/2)\,hy_0'' + \ldots]$$
$$\cong (y_1 - y_0)/h \quad (10)$$

Note that this last expression could have been written $\Delta y/\Delta x$.

We can obtain a more accurate expression than Eq. (10) by assuming $f(x)$ to be fitted by a quadratic.

$$f(x) = ax^2 + bx + c$$

Then taking successive derivatives until the final one is zero.

$$f'(x) = 2ax + b$$
$$f''(x) = 2a$$
$$f'''(x) = 0$$

The expression for y_1 is now

$$y_1 = y_0 + hy_0' + \frac{h^2}{2}y_0'' + \left[\frac{1}{3!}h^3y_0''' + \ldots\right] \quad (11)$$

Since we want to calculate the value of y_0', we must eliminate the y_0'' term in the above expression. This can be done by one of two methods.

(1) Evaluate y_2

$$y_2 = y_0 + y_0'(x_2 - x_0) + \frac{1}{2}y_0''(x_2 - x_0)^2 + \left[\frac{1}{6}y_0'''(x_2 - x_0)^3 + \ldots\right]$$

$$y_2 = y_0 + 2hy_0' + 2h^2y_0'' + \left[\frac{4}{3}h^3y_0''' + \ldots\right] \quad (12)$$

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Combining Eqs. (11) and (12) to eliminate y_0'', we find

$$y_0' = \frac{-3y_0 + 4y_1 - y_2}{2h} + \left[\frac{1}{6}h^2 y_0''' + \ldots\right] \quad (13)$$

(2) Evaluate y_{-1}. This is the value of y when $x = x_{-1} = (x_0 - h)$.

$$y_{-1} = y_0 - h y_0' + \frac{h^2}{2} y_0'' + \left[-\frac{h^3}{6} y_0''' + \ldots\right] \quad (14)$$

Then

$$y_0' = \frac{y_1 - y_{-1}}{2h} + \left[\frac{h^2}{6} y_0''' + \ldots\right] \quad (15)$$

This method can be extended to give as accurate an answer as desired with any set of points. It is helpful to keep the first neglected term in the series to give a general estimate of the possible error in the approximation.

For later use we list one of the many possible combinations:

$$y_0' = \frac{y_{-2} - 8y_{-1} + 8y_1 - y_2}{12h} + \left[\frac{4h^4}{120} y_0^{V} + \ldots\right] \quad (16)$$

Eq. (16) is obtained by eliminating y_0'' and y_0''' from the expansions for y_{-2}, y_{-1}, y_1 and y_2.

Problem 3—From the following table of data, find the value of the derivative at $x = 3$ using Eqs. (10), (15) and (16).

x_i	1	2	3	4	5
y_i	1.00000	0.50000	0.33333	0.25000	0.20000

Also compute the error for each approximation when compared with the analytical solution.

Solution:

(a) Analytic: $y = 1/x$; $dy/dx = -1/x^2$. When $x = 3$; $y' = -0.11111$.

(b) Using Eq. (10) where $h = 1$

$$\frac{dy}{dx} = \frac{y_1 - y_0}{h} = \frac{0.25000 - 0.33333}{1} = -0.08333$$

Error = 25.0%

(c) Using Eq. (15) where $h = 1$

$$\frac{dy}{dx} = \frac{y_1 - y_{-1}}{2h} = \frac{0.25000 - 0.50000}{2} = -0.12500$$

Error = −12.5%

(d) Using Eq. (16) where $h = 1$

$$\frac{dy}{dx} = \frac{1 - 8(0.5) + 8(0.25) - 0.2}{12} = -0.10000$$

Error = 10.0%

To illustrate the improvement in accuracy for smaller h values, assume we have the following data:

x_i	2.0	2.5	3.0	3.5	4.0
y_i	0.50000	0.40000	0.33333	0.28571	0.25000

(e) Using Eq. (10) where $h = 0.5$

$$\frac{dy}{dx} = \frac{0.28571 - 0.33333}{0.5} = -0.09524$$

Error = 14.3%

(f) Using Eq. (15) where $h = 0.5$

$$\frac{dy}{dx} = \frac{0.28571 - 0.40000}{1.0} = -0.11429$$

Error = −2.9%

(g) Using Eq. (16) where $h = 0.5$

$$\frac{dy}{dx} = \frac{0.5 - 8(0.4) + 8(0.28571) - 0.25}{6} = -0.11072$$

Error = 0.4%

Note for parts (b) and (e) the first term neglected is $-(1/2)hy_0''$. Then the error is proportional to the length of the interval. For (b) the error is 25.0% where $h = 1.0$ and for (e) the error is 14.3% where $h = 0.5$.

In the same manner the first term neglected for parts (c) and (f) is $-(1/6)\ h^3 y_0'''$. Hence, we expect that when the interval is reduced by a factor of two, the error will reduce by a factor of four. Compare 12.5% with 2.9%.

In parts (d) and (g), the error is proportional to h^4. Thus we expect the reduction in error from 10.0% to 0.4%.

We might point out that a more rigorous development of the integration formulas would also give terms to estimate errors. However, it is not within our scope to discuss the use of error factors.

We should emphasize again that we have avoided complicating our examples by assuming exact data. Actual data in most cases contains some error due to unaccounted for variations. The data should usually be smoothed in some manner. This is particularly true in the case of differentiation which tends to magnify these errors.

If the smoothing is done by least squares, the result is a mathematical expression which can be handled analytically. Integration of this expression is quite accurate. However, differentiation may not be. Dodge [1] points out on p. 251 that certain vapor-pressure equations may represent the data quite well but that the slope dp/dT is sometimes not satisfactory.

If the fit-the-curve-by-eye technique is used, points from the curve will usually be satisfactory for integration. In most cases they will also be quite good for differentiation.

Our presentation has been kept necessarily brief. When we consider that entire texts are devoted to numerical methods, we realize that the material contained here can only introduce the subject. We hope that this introduction makes other technical material more readable and gives some significance to comments authors make about numerical or graphical techniques used in their research.

There are numerous books and articles devoted to the material presented here. We have found a relatively short chapter in "High-Speed Computing Devices" [2] one of the best. Householder [3] has prepared an exhaustive survey of articles on numerical analysis. For chemical engineering examples see the mathematics section in Perry's Handbook.[5] Also the discussions of relaxation and graphical techniques in McAdams.[4]

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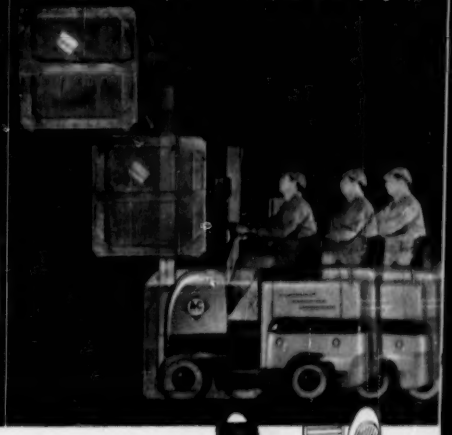

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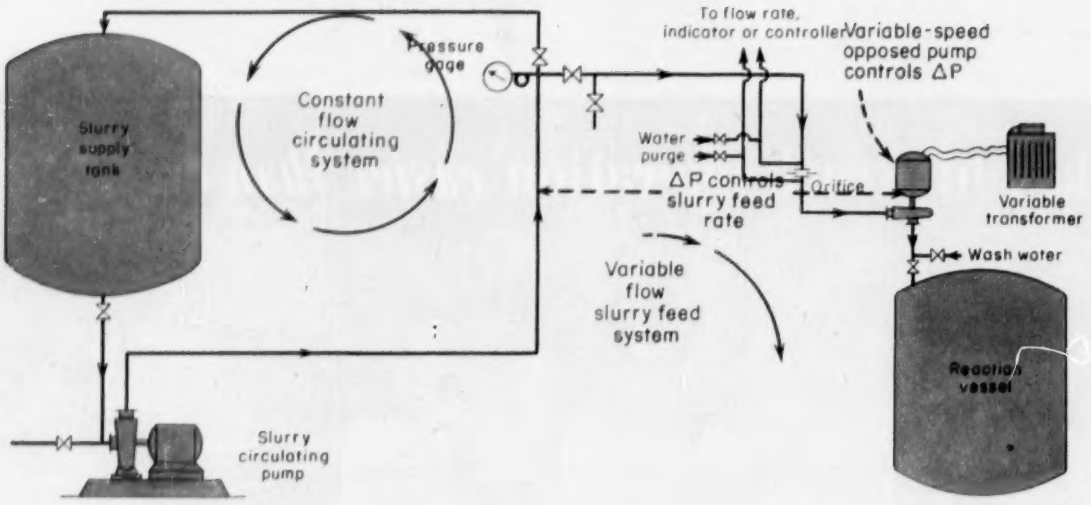

Controlling Flow of Rapid-Settling Slurries

Smooth flow control comes from opposing the flow with a variable-speed centrifugal pump instead of a valve.

★ **September Contest Winner by**
C. W. Roos
Research Dept., Organic Chemicals Div., Monsanto Chemical Co., St. Louis, Mo.

Accurate control of flow of slurries is often a problem in operations ranging all the way from laboratory to full-scale plant. The problem is especially difficult when the slurry is coarse and rapid-settling, and is emphasized on a laboratory or pilot-plant scale. However, we have found a solution which seems to be practical in all cases.

We encountered the problem when handling slurries made up of 30 to 40% by volume of solid sodium sulfite (50 to 100 mesh particle size) in a saturated water solution. Various flow rates within the range of 1 to 2 gph. in the laboratory, and 2 to 5 gpm. in the pilot plant were to be maintained constant. For both of these operations, the use of several types of throttling valves proved to be entirely unsatisfactory. If the valves were partially closed, they would plug with solids, and if they were gradually opened, a sudden large flow of slurry would occur as the solids broke loose.

This difficulty was solved by use of a small variable-speed centrifugal pump connected in opposition to the desired direction of flow. Rather than to use a valve to produce the pressure drop needed to restrain the slurry flow, we obtained the pressure drop by means of energy applied to the centrifugal pump. A schematic diagram of the piping set-up appears in sketch above.

The main supply of slurry is

NEXT MONTH: Pin-up Panel for Control Board Design

By A. James Waldron, Winner of the October Contest

★ How Readers Can Win

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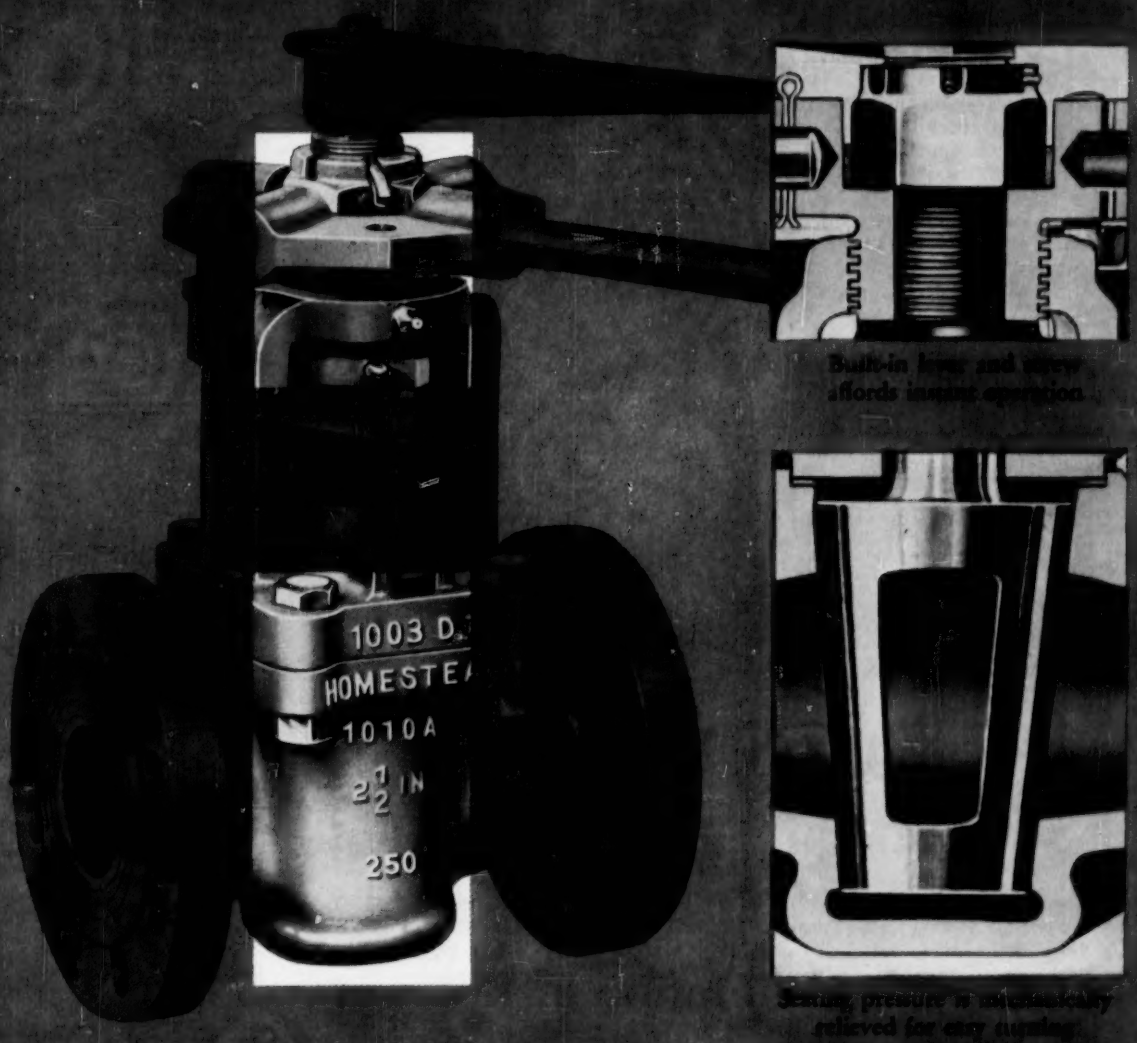

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kept moving at a relatively high velocity through a circulating line passing near the system feed point. Sufficient pressure is maintained in the circulating line to permit slurry feed to the reaction system at somewhat more that the maximum desired rate when the control pump is off. The control pump is installed between the feed point and the circulating line in such a way that lines carrying the controlled flow will drain either into the reaction system, or back into the circulating line, on shut-down. The control pump is able to produce sufficient pressure as maximum speed so as to stop the flow of slurry into the system.

In the laboratory application, we used a single 1/20-hp. laboratory centrifugal pump as the control pump. In the pilot plant, three of these laboratory pumps were connected in series to give the maximum back pressure required to shut off the flow at maximum pump speed. A convenient way to vary the speed of the pumps is to use a standard laboratory variable autotransformer. Flow rates can easily be adjusted to any desired value within the operating range and can be maintained constant over a several-day period with only occasional slight adjustments of pump speed. Such a control pump can also be used as a final control element in an automatic system where continuous control of pump speed maintains a desired flow rate.

We have successfully metered flow rates in the pilot plant with a ¼-in. diameter orifice assembly mounted in a vertical run of 1-in. pipe between the circulating line and the control pump. In the laboratory operation, we fed slurry from a calibrated storage tank.

In larger scale operations, conventional flow-control valves are usually fairly satisfactory for this type of slurry. However, this system has made it possible to control slurry flow stably on pilot plant and laboratory scales and it promises to be an improvement in several large scale control systems.

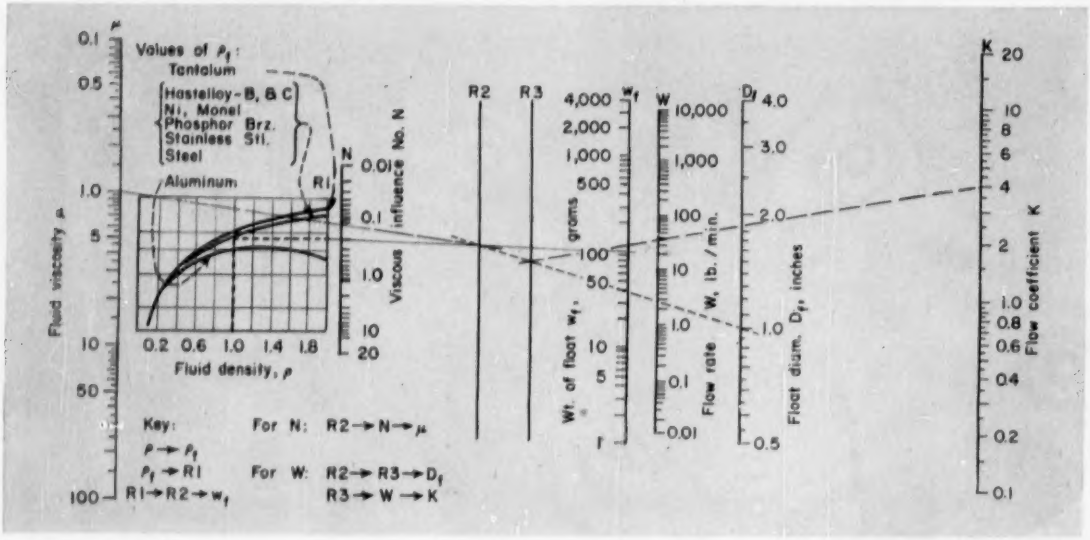


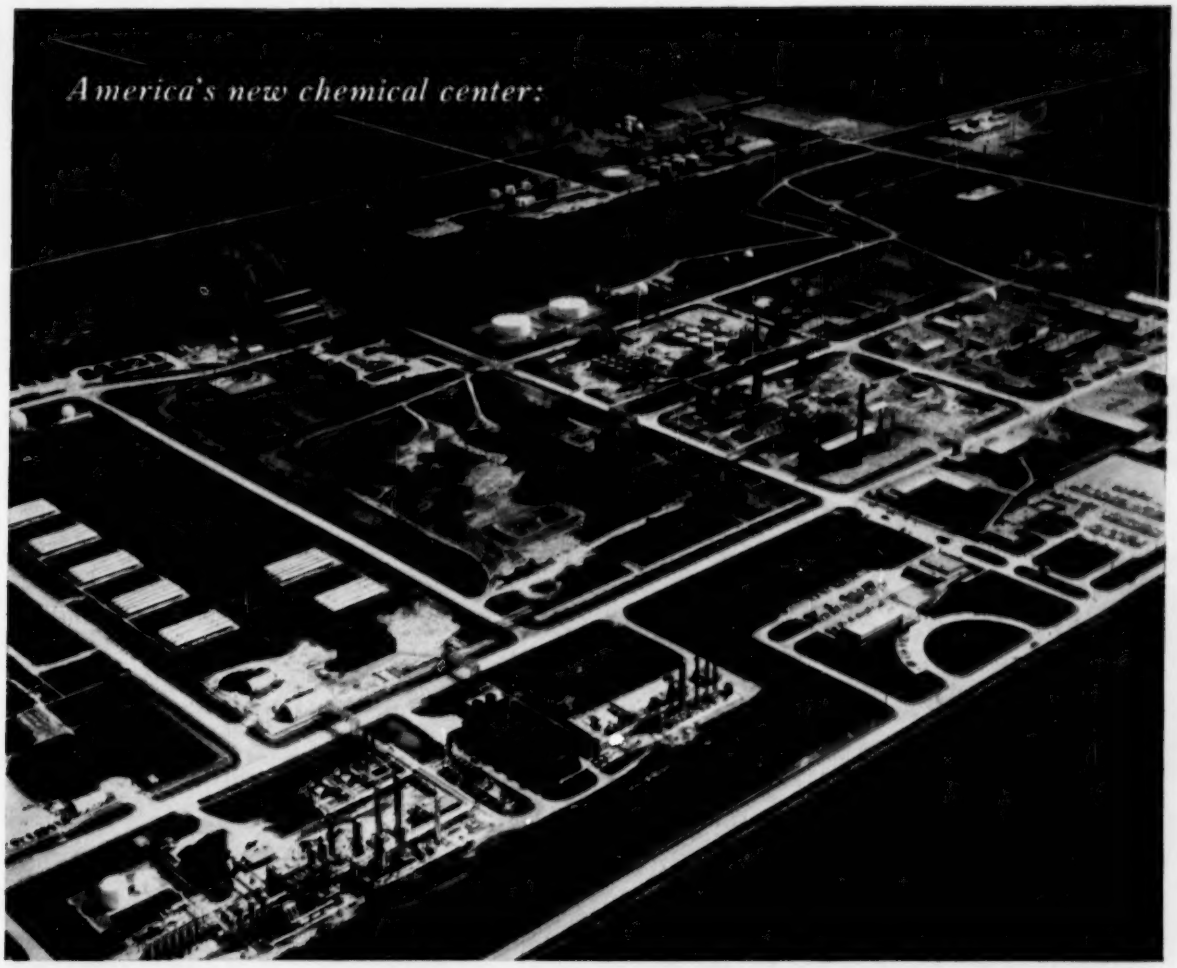
Chart Aids Calibration of Rotameters

George M. Machwart
Michigan College of Mining & Technology, Houghton, Mich.

Variable-area flow meters, and particularly rotameters, have long been used for rapid and accurate flow metering and controling. Systems of floats have been developed which permit prediction of calbration from a known calibration on another fluid.[1, 2] Characteristics of such meters are best presented in terms of percentage of total flow and actual flow is then calibrated from the factors: viscous influence number $N = \mu/F$, which is a modified Reynolds number; the basic flow equation $W = KD_fF$; and a simplified flow coefficient K. These terms are described fully in References (1) and (2).

In these expressions $F = [w_f\rho(\rho_f - \rho)/\rho_f]^{\frac{1}{2}}$. N is a dimensionless number; μ is viscosity, centipoises; W is flow rate, lb./min.; K is a flow coefficient; D_f is float diameter, inches; w_f is float weight, grams; ρ is fluid density and ρ_f is float density, both in grams/cc. If the float has a tail guide an additional correction factor C is introduced into the righthand side of the basic flow equation.

Charts have appeared[3] to solve these equations but their combination as the single nomograph given here is more convenient. This makes use of the common



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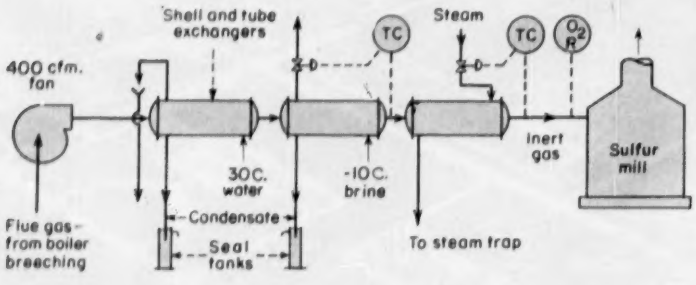
term F appearing in the equations for both W and N.

As an example of use of the nomograph, assume a stainless steel float of 1 in. diameter, weighing 100 grams, used to meter a fluid of density and viscosity 1.0 when $K = 4.0$. Following the key, go from $\rho = 1.0$ vertically to the curve for stainless, then horizontally to line R_1. Find R_2 from R_1 and w, and N from R_2 and $\mu = 1.0$. Then find R_3 from R_2 and $D_f = 1.0$, finally locating $W = 40$ lb./min. from R_3 and $K = 4.0$.

REFERENCES

1. Fischer, K., *Chem. Eng.*, **59**, 180-4 (June 1952).
2. "Variable-Area Flow Meter Handbook", Fischer & Porter Co., Hatboro, Pa., 1952.
3. *Chem. Processing*, Sept. 1946.



Non-Corrosive Inert Gas From Flue Gas

David Wittenberg
Consulting Engineer, Kiryat Motzkin, Haifa, Israel.

One of my clients wanted to grind sulfur to 350 mesh in two Raymond ring-roll mills each of 600 lb./hr. capacity. For safety it was necessary to supply about 1,000 lb./hr. of inert gas to the mills. The mill manufacturer suggested a combustion gas of at least 10% CO_2 (11% O_2 max.).

Use of nitrogen would have been too expensive. Also, to burn coke to get a high-grade inert would have been too costly. The plant's boiler operated on a heavy fuel oil containing 2% sulfur which meant that the combustion gases would contain considerable SO_2, plus water vapor. At the desired entering temperature of 60 C. the gases would cool in the mill to 30 C. in summer and to 20 C. in winter, which would lead to condensation and corrosion of the mill.

To build an acid-resisting water scrubber would have been expensive, would have meant considerable wastage of contaminated water, and would have required subsequent gas drying.

The solution lay in cooling the gas in two stages to 5 C. and thus condensing out enough moisture so that on reheating to the desired 60 C. there would be no condensation as cooling took place in the mill, since the temperature would always be above the dewpoint.

I used three shell-and-tube exchangers with aluminum tubes and mild steel shells for the coolers and reheater. First-stage cooling with water at 30 C. dropped the gas to 40 C. Second-stage cooling with an available brine at −10 C. lowered the temperature further to 5 C. In both coolers condensation was bled off through a seal vessel of lead or aluminum. The reheating step then used steam to reheat to 60 C.

Temperature controllers held the desired temperatures on the second-stage cooler and the reheater, while an O_2 controller controlled combustion conditions in the boiler.

Low Cost Way to Get High Vacuum

For small scale pilot-plant and laboratory operations, vacuum approaching 5 mm. abs. can be produced in a very simple way suggested by Schutte & Koerting.

Using a water-jet exhauster is a well-known method of producing vacuum. The new idea involved in the present suggestion is to use recirculated ice water as the motive fluid. At 35 F., for example, the vapor pressure of water is 5.17 mm. Hg which is the limit of vacuum produced.

The setup consists of a small insulated tank for water and ice, provided with a small electrically driven positive displacement pump. The pump discharges through a small water-jet ejector such as the type made by S & K, then back to the tank.

As an example, a size "00" jet exhauster using 6 gpm. of water at 35 F. and 55 psig. will exhaust a 5-liter system from atmospheric to 6 mm. Hg abs. in 3 min.

This idea was originally developed to solve the corrosion problems in vacuum distillation of acid chlorides. When oil-sealed mechanical pumps were used, pumps failed from corrosion despite the use of traps and frequent oil changes.

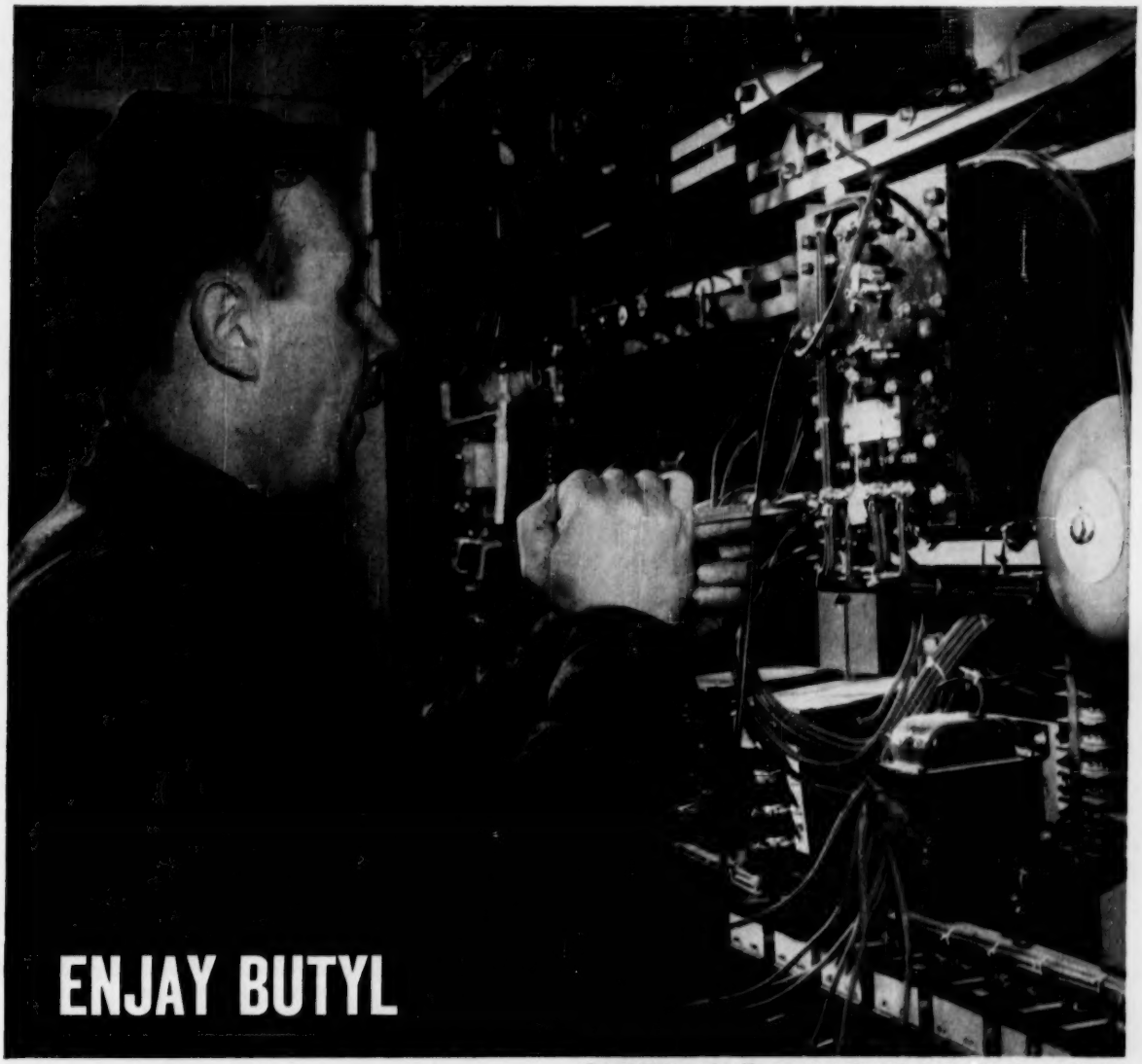
All equipment needed to set up a small-scale vacuum producer of this type can be obtained as standard, including a tank, a pump, a jet exhauster, a pressure gage on the pump discharge and a shut-off valve between exhauster and evacuated system.

How to Lick a Plugged Slurry Valve

Attempts to throttle the flow of slurries with a control valve usually result in plugging, with consequent wider opening of the valve, followed by breaking free, over-feeding, and cycling.

Control Engineering describes a simple solution to the problem. The slurry is recirculated continuously by a pump from the feed vessel to a flow splitter. At the splitter, part returns to the feed vessel, part flows on to the controlled process. The controller then positions the splitter nozzle at all times so that the desired part of the total flow goes to the process, any excess returning to the feed vessel.

With a pneumatic controller, for example, a diaphragm motor top can easily be adapted to position the splitter nozzle.



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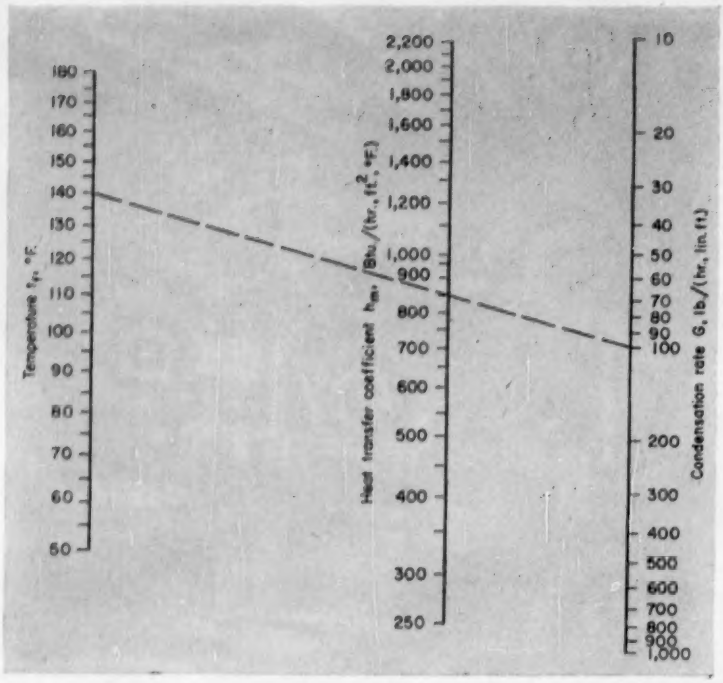


Chart for Condensing Film Coefficients

Y. P. Varshni

Department of Physics, Allahabad University, Allahabad, India.

In many condensing problems, water vapor condenses at subatmospheric pressures. For vapor condensing outside tubes most texts give the equation:

$$h_m = 1.5\,\phi_f\,(4G/\mu_f)^{-1/3} \qquad (1)$$

where $\phi_f = (k_f^3\rho_f^2 g/\mu_f^2)^{1/3}$; $G = W/LN$ for horizontal tubes; and $G = W/\pi D_o N$ for vertical tubes.

Recently Fan (*Chem. Eng.*, p. 208, Apr. 1956) presented a simple empirical equation for determining ϕ_f and μ_f in terms of t_f. A still further simplification is possible. Eq. (1) can be put in the form:

$$h_m = A/G^{1/3}$$

where $A = 1.5\,\phi_f\,(\mu_f/4)^{1/3}$

I have found that the following equation:

$$A = 15.873\,t_f + 1{,}742 \qquad (2)$$

represents the variation of A with t_f very well. For example, by comparing calculated values of A with observed values (from Forsythe in "Smithonian Physical Tables", 1954) for values of t_f from 50 F. to 176 F., I found the maximum error to be -0.92% at 86 F., all other errors being less than $+0.43\%$. Thus the equation becomes:

$$h_m = (15.873\,t_f + 1{,}742)/G^{1/3} \qquad (3)$$

Nomenclature

D_o	Outside diam. of tube, ft.
G	Condensation rate, lb./(hr., lin. ft.)
g	Acceleration of gravity, ft./hr.²
h_m	Mean value of heat transfer coefficient of condensate film, Btu./(hr., sq. ft., °F).
k_f	Thermal conductivity of condensate film at t_f, Btu./(hr., ft., °F.).
L	Length of tube, ft.
N	Number of tubes
t_f	Condensate film temperature, °F.
W	Condensate rate, lb./hr.
ϕ_f	$(k_f^3\rho_f^2 g/\mu_f^2)^{1/3}$
μ_f	Abs. viscosity of condensate at t_f, lb./(hr., ft.).
ρ_f	Condensate density at t_f, lb./cu. ft.

This equation was used to construct the nomograph given for evaluating h_m in terms of G and t_f.

As an example, 2,000 lb./hr. of steam condenses outside a 1-in. horizontal tube 20 ft. long. If the condensate film temperature is 140 F., what is the heat transfer coefficient? Here $G = 2{,}000/20 = 100$. The nomograph shows h_m to be 850, compared with 856 as the value calculated from known values of k_f, ρ_f and μ_f.

Tinned Threads Make Leakless Joints

Buckley Sullivan
Cleveland, Ohio.

Occasionally, in medium-pressure service, screwed pipe fittings will leak even when the threads are apparently perfect and the joint is made up with care. The same thing happens even more frequently in high-pressure air and water lines.

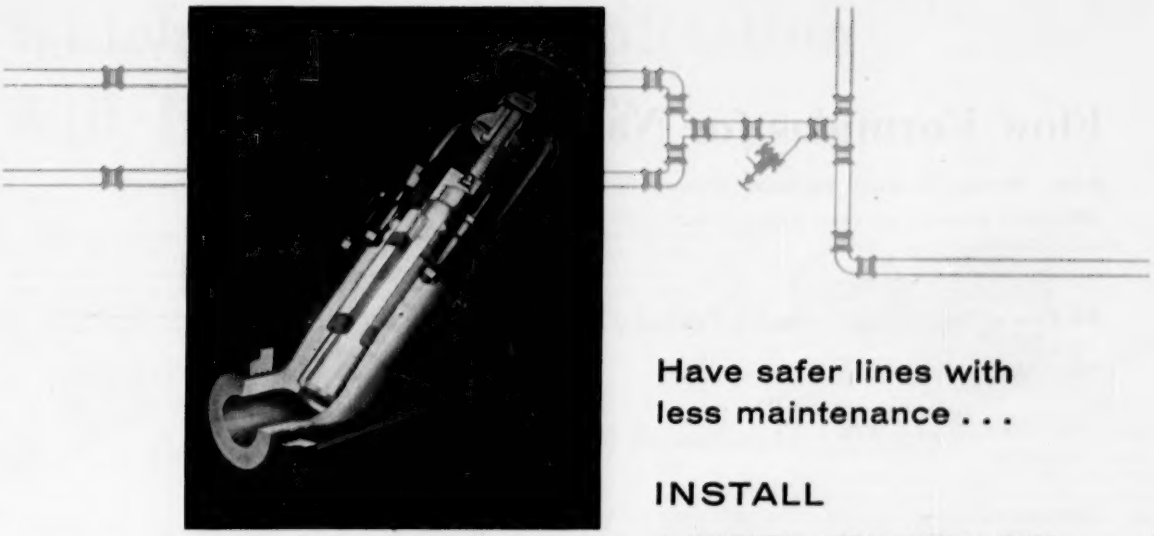
An easy way to lick these troublesome joints is to tin the male threads lightly with solder before the joint is assembled. After assembly, a touch of heat will resolidify the solder forced off the threads by the female component. The resulting joint will defy leakage, yet is fairly readily torn down if necessary.

Steam Filter Cake to Avoid Solvent Loss

Arthur J. Weinberger
Bridgeport, Conn.

Waste filter cakes may hold as much as 1 to 2 lb. of valuable solvent per/lb. of dry solid. This solvent can't be recovered by air-blowing in the filter without an absorption unit or refrigerated condenser.

However, steaming the cake in the filter will recover the solvent almost quantitatively if the effluent vapor is condensed. Air-blowing after steaming will leave the cake cool and dry. A horizontal plate filter is preferred since there is less chance of steam channeling.



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Flow Formulas for Natural Gas

Maxey Brooke, Chemical Engineer, Sweeny, Tex.

(For author biography see *Chem. Eng.*, July 1957, p. 318)

40. Flow of Natural Gas Through a Pipeline at High Pressure

FORMULA

$$Q = 18.062 \frac{T_s}{P_s} \left[\frac{(P_1^2 - P_2^2) d^{16/3}}{STL} \right]^{0.5}$$

REFERENCE

T. R. Weymouth, *Trans. ASME*, **34**, 185–206 (1912).

NOMENCLATURE

d	Pipe diameter, in.
L	Length of pipeline, miles
P_s	Base pressure, psia.
P_1	Inlet pressure, psia.
P_2	Outlet pressure, psia.
Q	Volume, cu. ft./hr.
S	Specific gravity of gas (air = 1.0)
T	Temperature of flowing gas, deg. F. abs.
T_s	Base temperature, deg. F. abs.

41. Flow of Natural Gas at Low Pressure

FORMULA

$$Q = 3{,}550 \left[\frac{d^5 H}{Sl(1 + 3.6/d + 0.03d)} \right]^{0.5}$$

REFERENCES

1. J. M. Spitzglass, *Armour Engineer*, March and May 1917.
2. J. M. Spitzglass, *Am. Gas J.*, **96**, 274 (1912).

NOMENCLATURE

d	Pipe diameter, in.
H	Pressure drop, in. water column
l	Length of pipe, ft.
Q	Flow, cu. ft./hr.
S	Specific gravity of gas (air = 1.0)

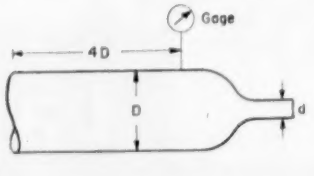
42. Flow of Natural Gas to Atmosphere Through a Swaged Nipple

FORMULA

$$Q = 25{,}500 d^2 (p + 14.4)$$

LIMITATIONS

1. Locate pressure tap as shown in diagram and preceded by minimum straight run of pipe equal to four times supply pipe diameter.
2. Gage pressure is not less than 12 psi.
3. Diameter of outlet nipple d is not less than $0.66D$.



REFERENCE

Bulletin E-7, American Meter Co., New York

NOMENCLATURE

D	Diameter of supply pipe, in.
d	Diameter of outlet nipple, in.
p	Gage pressure, psi.
Q	Flow, cu. ft./24 hr.

43. Flow of Gas in Tapered Lines

FORMULA

$$Q = 97{,}100 \sqrt{\frac{(P_1^2 - P_2^2)(D_2 - D_1)(D_1 D_2)^{5.333}}{GLT(D_2^{5.333} - D_1^{5.333})}}$$

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1. Jones, *Western Gas*, May 1929.
2. Harris, *Trans. ASME*, **34**,185 (1912).
3. "The Gas Engineers Handbook," 1st Ed., McGraw-Hill Book Co., New York (1934).

NOMENCLATURE

D_1	Upstream diameter, in.
D_2	Downstream diameter, in.
G	Specific gravity of gas (air = 1.0)
L	Length of pipe, ft.
P_1	Upstream pressure, psi.
P_2	Downstream pressure, psi.
Q	Flow, cu. ft./hr.
T	Temperature, deg. F. abs.

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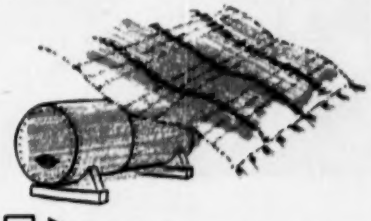
☐ ▶ **Simplifies Pulverizing of Materials With Low Melting Point**—Many substances tend to melt or smear because of the heat generated in a milling process. DDT and vegetable fat flakes which are waxy and Teflon resin which is very tough and elastic are examples. In the low temperature pulverizing process the ingredient is mixed with crushed dry ice or low pressure carbon dioxide liquid is injected directly into the ingredient. These methods effectively inhibit the melting or smearing, prevents plugging and reduces horse power requirements. Gaseous carbon dioxide is also used to form an atmospheric "blanket" to effectively prevent fire during the grinding of flammable materials. An example of this application is the grinding of phosphorus pentasulphide and flammable resin materials.

☐ ▶ **Fireproof "Blanket" For Stored Phenol**—Phenol is a toxic, corrosive, flammable compound and is stored in an inert atmosphere under slight pressure to reduce vaporization, prevent oxidation and at the same time provide a non-flammable atmosphere. Carbon dioxide is also used as a pressure medium in transferring liquid phenol.



☐ ▶ **Effective Inerting Agent**—There are many times when an inert atmosphere is needed to prevent fire or explosion. Before welding a tank that has been used for the storage of flammable liquid, CO_2 is used to inert the atmosphere in the tank so that welding can be done with no danger of explosion. CO_2, acting as an effective atmospheric "blanket," also prevents oxidation and "skinning" of paints and oils.

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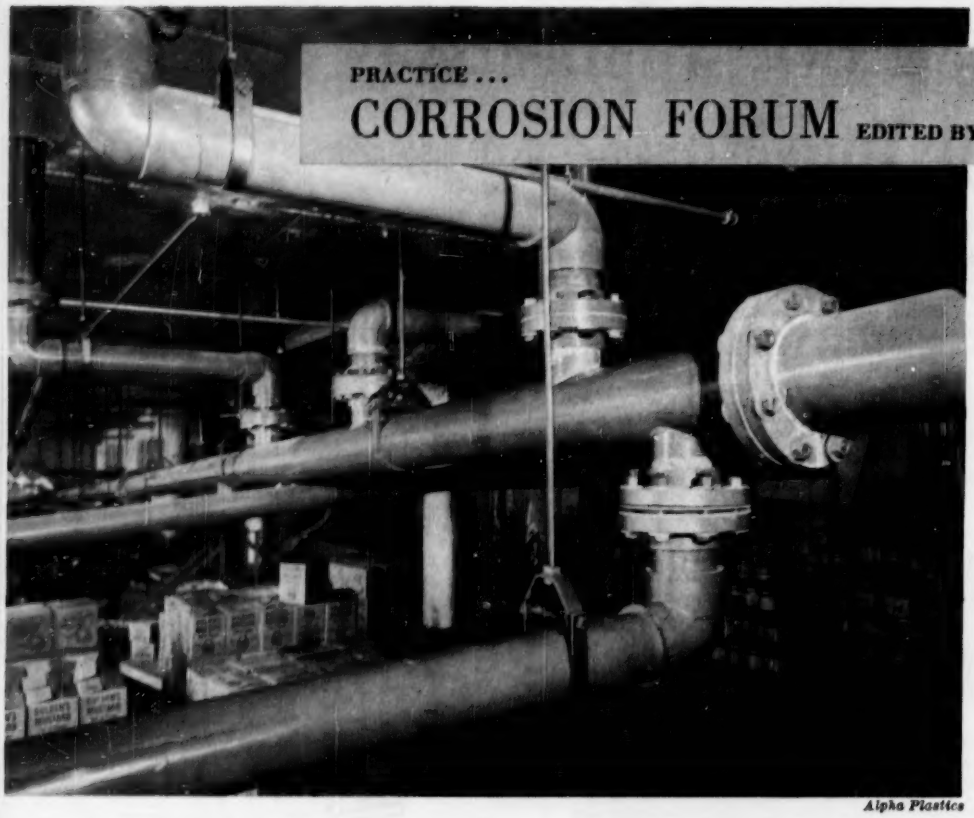


Alpha Plastics

How to Work With Rigid PVC Plastic Piping

With engineering techniques now well developed, here is the latest on how to machine, install, support, bend, and repair PVC pipe.

James P. Kellcher, Corrosion Engineer, Carpenter Steel, Union, N. J.*
C. L. Mantell, Dept. of Chem. Eng., Newark College of Engineering, Newark, N. J.*

Many chemical engineers, not familiar with plastic piping materials, are surprised to find that well developed engineering techniques are available for machining, bending, installing and repairing plastics. This is particularly true for PVC pipe, the most generally used plastic pipe (*see Chem. Eng., Nov.* 1957, *p.* 296) in the chemical industry.

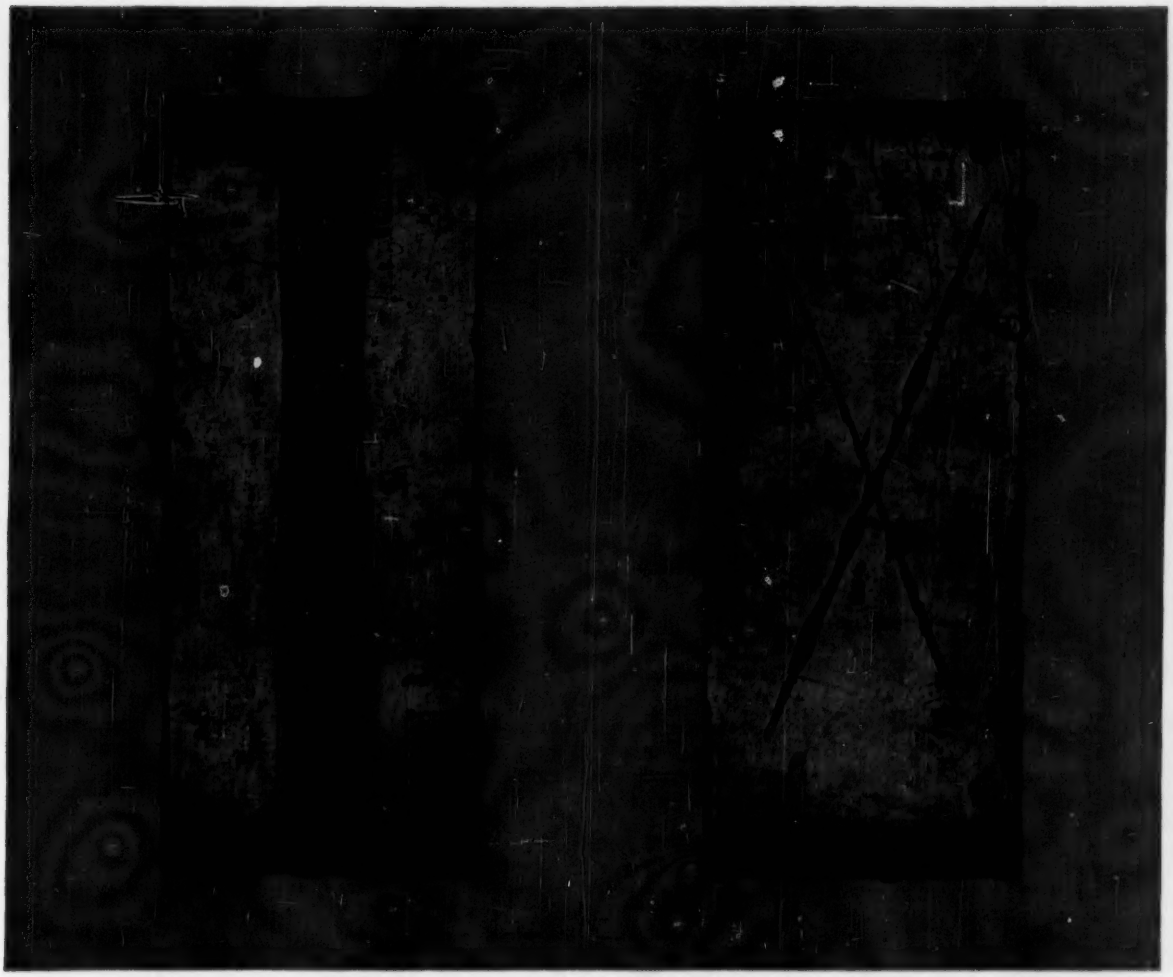
Most conventional machining operations can be effectively performed on rigid polyvinyl chloride. You can assume these materials are machinable with similar ease and on types of equipment normally encountered in working with brass.[1] However PVC is a poor conductor of heat, and being thermoplastic will tend to soften and smear at elevated temperatures. Operations should be performed to generate a minimum of heat, and cooling should be provided when required.

Another consideration is the high notch sensitivity of these materials, particularly Type I (unplasticized PVC). Thought should be given in the machining process to minimize sharp notches or deep grooves during fabrication as well as in the part design.

Cutting of pipe prior to assembly and installation can be best accomplished by means of a hack saw or a circular power-saw having fine-tooth blades with no set. Rotary pipe cutters should not be employed. The cuts should be square and smooth. If clamping is required, protect the pipe from crushing and scoring with canvas or paper wrap.

With metallic piping it is general practice to thread only schedule 40 (standard weight) pipe or heavier. With Type I and Type II (contains fillers to increase impact strength) polyvinyl chloride, however, the minimum schedule of pipe for threading is generally schedule 80. As with cutting, the pipe should be held in such a manner that it will be protected from crushing or scoring by wrapping in canvas, paper, or similar material. Pipe cutting machines are desirable but standard hand pipe stocks are equally effective.

* To meet your authors see *Chem. Eng.*, Nov. 1957, pp. 325 and 329.



CORROSION'S FOCAL POINTS are easy to detect with a new Amercoat testing method using iron and caustic indicators in a saline gelatin bath. On the welded and scored steel panels shown above after test, unworked surface areas turned red to indicate cathodic properties; but the weld, scores and edges turned blue (here shown blackened) to reveal themselves as anodic corrosion breeders. Rivets, threads, crevices and abrasions also show anodic under test. Unless such areas are effectively sealed from moisture, oxygen and ions they will erupt as focal points of corrosion cells.

How to protect "trouble spots" against corrosion

Ask a corrosion engineer where metal corrosion is likely to attack first. Chances are that he will name rivets, threads, sharp edges, angles, crevices and welds. These are the areas of stress concentration, work hardness, fissures and abrasions. They tend to be anodic and actually breed corrosion. And although they warrant increased protection, conventional coatings pull away from their sharp profiles and leave them inadequately covered.

Amercoat No. 87, a true vinyl mastic, protects these spots in a single coat 10 mils thick, whereas other coatings fail to build 5 mils in three coats. It cuts maintenance painting costs up to 50% because you don't have to re-erect staging and scaffolds for additional coats, and you get results that last.

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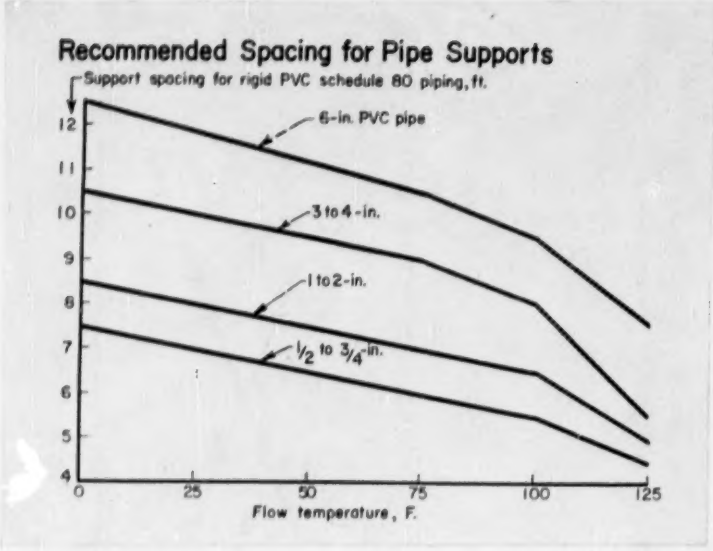

Dies should be clean and sharp with a negative front rake angle of zero to five degrees. Dies which have been designed for use on copper or brass pipe can be used. No lubricant is necessary, but the washing away of cutting is considered good practice and generally recommended. Avoid overthreading, since an extra long threaded portion will make it impossible to run the fitting or valve on far enough to obtain a tight seal. The use of American Standard thread dimensions will give pipe threads compatible with available threaded fittings and valves.

Threaded Joints: Notch Sensitive

Thread sealing and lubricating compounds should be employed which are compatible with either type of polyvinyl chloride and which are satisfactorily resistant to the particular fluid being handled.

Such a suitable compound should be applied to the male thread, and the fitting or valve then screwed on carefully until it is hand tight. The joint is then further tightened with a strap wrench (not a Stillson wrench) so that the final joint is approximately a one-quarter to one-half turn past hand tight. It is very important that threaded joints in these materials not be overtight, since such joints will tend to relieve themselves and result in leakage.

Cemented Joints: Strong, Durable

Socket-type fittings and valves are available in both Type I and Type II PVC, which permit the joining of piping systems by the use of a solvent cement.

Dimensions and tolerances of these fittings and valves are so designed that a joint made with properly compounded cement is physically and chemically equivalent to the pipe and fitting used.

The available solvent cements are proprietory, but essentially consist of a strong solvent system in which polyvinyl chloride has been dissolved. These cements have a solids content of approximately 10-15%.

Burrs, grease, and dirt from the end of the pipe and from the socket of the fitting or valve must be removed. Joint surfaces are then wiped with methyl ethyl ketone to break down the hard, glazed surface from the extrusion or molding process. Then a generous amount of cement is brushed all over the socket wall and on the end of the pipe to match the depth of engagement. The joint is then immediately engaged by pushing the pipe firmly against the shoulder of the socket and rotating approximately one-half turn.

The joint sets in several seconds, so there is no delay in proceeding with the next joint or other handling of the piping system. However, full strength, equivalent to that of the joint components, is not realized for approximately 24 to 48 hours.

Solvent-cemented joints have an advantage over threaded joints. They can be rapidly put together with a minimum of training and they eliminate the problems of notch-sensitivity inherent in a thread. They also permit the use of lighter weight piping, thus effecting cost savings. On the other hand, solvent-cemented joints are permanent —they eliminate the possibility of disassembly and re-use of components.

Repair With Heat Welding

One of the most important characteristics of rigid polyvinyl chloride as a material of construction is that it can be hot-gas welded in a manner analogous to the welding of metal.

For the fabrication of structures other than piping systems, and for the shop fabrication of piping components which cannot be readily obtained otherwise (non-standard or large diameter fittings), this characteristic is a distinct advantage.

However, in the actual assembly of a piping system, the technique is not generally practiced. Although such joints can be made, they require a fairly high degree of skill, are time-consuming and more costly, and do not appear to offer any advantage over threaded or solvent-cemented joints. In view of this, it appears that the principal utilization of this technique in rigid PVC piping would be for the repair of threaded or solvent-cemented joints which fail because of improper initial assembly or for some other reason.

In brief, this technique involves the softening of a weld rod and the work to be welded, which results in a bond between the contacting surfaces when pressure is applied. Heat for softening is supplied by the passage of heated air or other suit-

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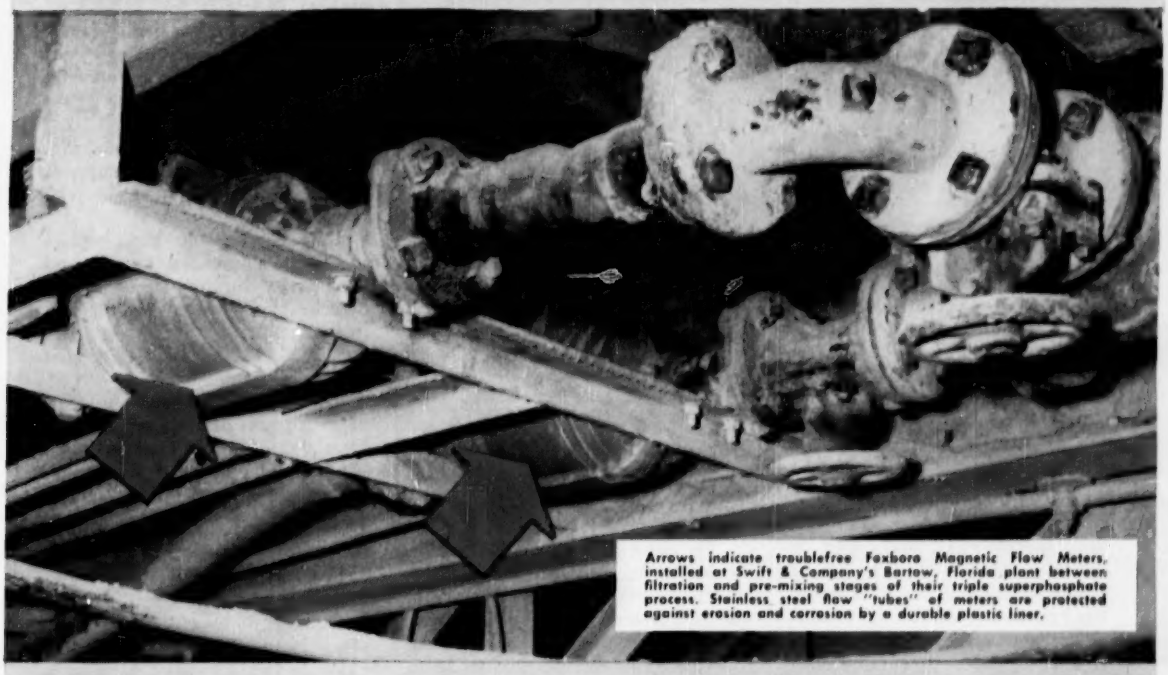

Arrows indicate troublefree Foxboro Magnetic Flow Meters, installed at Swift & Company's Bartow, Florida plant between filtration and pre-mixing stages of their triple superphosphate process. Stainless steel flow "tubes" of meters are protected against erosion and corrosion by a durable plastic liner.

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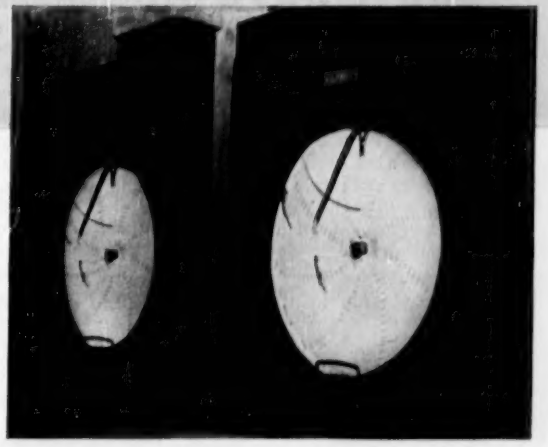

By watching slurry flow rates on Dynalog Recorder charts, operators precisely regulate feed of H_2SO_4 to the reactor tanks . . . permitting better quality control right down the line.

Measuring slurry is duck soup for two Foxboro Magnetic Flow Meters now used in the production of Swift & Company's Agricola plant food. Here's the story.

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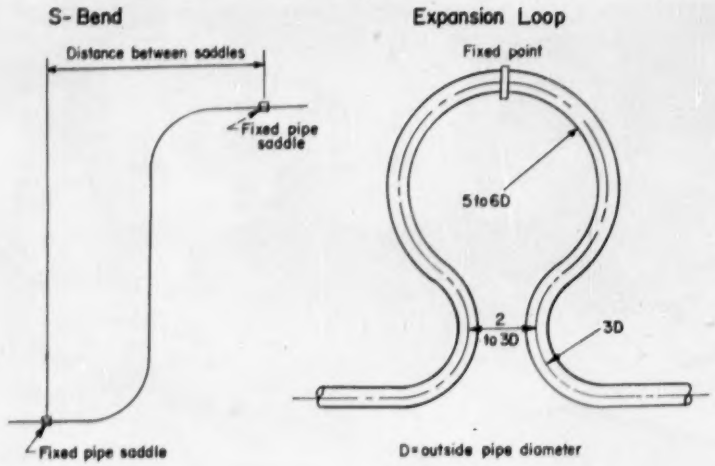
MAGNETIC FLOW METERS

How to Allow for Thermal Expansion



able gas over the surface of the work and the rod. The gas is generally heated to a temperature of 500 to 550F.[3] by electrical resistance methods: welding equipment is commercially available which permits rather close control of both gas temperature as well as velocity of the gas.

How to Make Non-Standard Fittings

In the installation of any piping system it is often desirable or necessary to bend the piping material. Rigid polyvinyl chloride can, in many cases, be adapted to this method of fabrication. An example would be where a long radius elbow is required but is not available as a standard fitting. Another example would be the fabrication of an expansion loop.

To bend rigid polyvinyl chloride piping, the section must be heated uniformly to 260 to 275 F. in a hot air oven, hot oil bath, hot gas stream, or other heating device. The section is then bent around a form of proper radius. It is generally considered good practice to limit the radius of bend to a minimum of 10 times the diameter of the pipe. Rapid cooling is recommended to quickly set the bend. To prevent collapse or flattening during the bending operation, the pipe may be filled with hot sand, a coil spring, or an inflated rubber tube. Care must be exercised to get a uniform bend in PVC pipe.

Critical Factor: Support Spacing

The usual types of hangers and support may be used with rigid polyvinyl chloride piping, but sharp edges and burrs are to be avoided. The recommended support spacings for Type I or Type II polyvinyl chloride schedule 80 pipe, uninsulated and carrying liquids up to 1.2 specific gravity are as shown on page 302.

Above 125 F., it is good practice to use continuous support such as cradling in angle iron sections.

For schedule 40 pipe, spans should be decreased 1 foot, and for heavier liquids, spans should be decreased by ½ to 1 foot. For insulated lines, support spacing should be 70% of distances given.

Additional support should be provided at fittings or valves Pipe should not be clamped solid —allow for thermal expansion and movement.

Design for Thermal Expansion

Type I polyvinyl chloride has a rate of thermal expansion approximately 5 times that of steel, and Type II polyvinyl chloride has a rate of expansion approximately 10 times that of steel. Thus, thermal expansion of these materials must be given consideration in designs. However, their thermoplastic nature limits application to a narrow range of temperatures, thus offsetting to a degree, difficulties which high thermal expansion might present.

Where over-all temperature range is less than about 50 F. for Type I or less than 30 F. for Type II, compensation is generally not required, unless the run of piping is quite long. For wider ranges of temperature, it is very often possible to utilize directional changes to absorb expansion, providing an anchor point and loose clamps to control movement of each section. However, this method is not generally recommended at temperatures under 40 F., especially with Type I polyvinyl chloride and threaded joints.

In straight runs, where ends are constrained and thermal compensation is called for, expansion joints or expansion loops are available which are constructed to provide a given increment of expansion or contraction. The required thermal compensation may be estimated

Thermal Expansion of Rigid PVC Piping

Temperature Rise (Drop), F.	Increase (Decrease) in Length of a 10-Foot Length, In.	
	Type I PVC	Type II PVC
20	1/16	1/8
40	1/8	9/32
60	3/16	13/32
80	9/32	17/32
100	11/32	21/32
120	12/32	13/16
140	15/32	15/16
160	17/32	1 −1/16
180	19/32	1 −3/16

Sam Spinner's Mail Box

by Sam Spinner

CASE #1

Problem: Can we do centrifuging on a completely automatic basis?

Solution: You'll find the answer in the photograph and the flow chart at the right. Note that liquor outlet and solids discharge chutes operate simultaneously — automatically.

CASE #2

Problem: A particularly hard packed solid had given a plant owner considerable trouble in plowing from his centrifugal machine. His method of plowing consisted of jogging his motor to maintain a plowing speed. This resulted in constant inrushes of power that overheated and burned out his expensive Main Drive Motor.

Solution: AT&M positive speed Unloading Drive was installed as an integral part of the Main Drive Motor. This Unloading Drive, powered by a separate 2 H.P. plowing motor, gave a constant plowing speed of 45 R.P.M. through a rugged worm and gear drive. The operator was able to devote his entire attention to the plowing. The Main Drive Motor, relieved of its plowing duty, gave no further trouble.

CASE #3

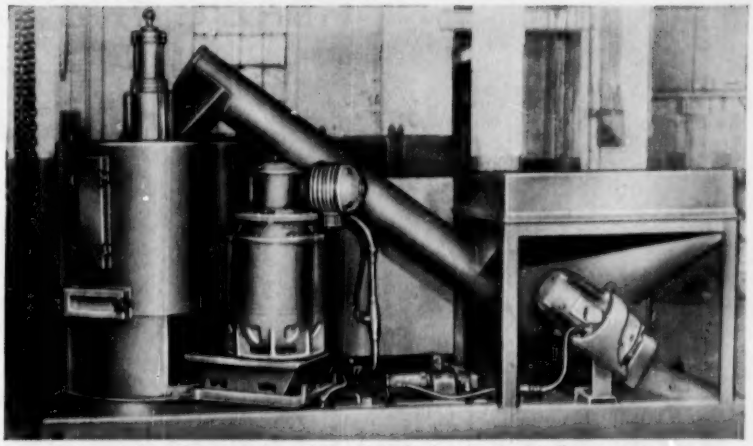
Problem: A valuable high viscosity slurry required a high speed clarifier to separate the solids from the liquor. Due to the characteristics of the slurry the conventional type baffle basket could not be used.

Solution: AT&M built a Link-Suspended Type Centrifugal that developed 2000 x gravity. The solid bowl basket with special baffles, built to distribute the load evenly, gave the proper separation.

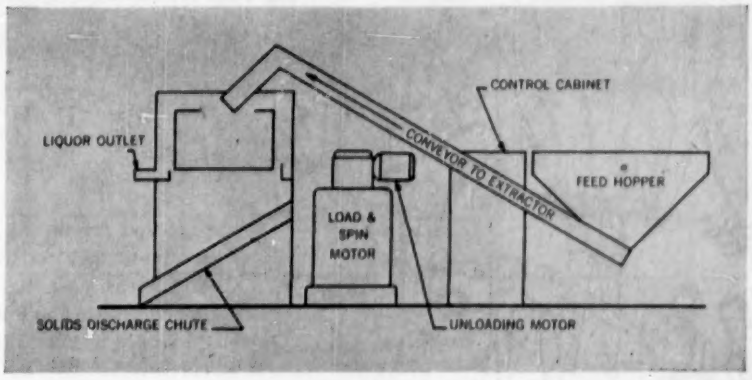
CASE #4

Problem: An application of a Suspended type centrifugal, with its convenience of plowing out through the bottom, was complicated by the lack of headroom to accommodate the conventional type Direct-Driven Machine.

Solution: A V Belt driven Suspended Centrifugal, with the motor suspended in an inverted position at one end of the frame, provided the answer to the limited headroom. An AT&M Unloading Drive mounted on this inverted motor provided a positive slow speed drive for plowing.



AT&M centrifugal for separating solids and liquids loads automatically, separates automatically, unloads automatically.



Solids Separated from liquids automatically—fast

This is another AT&M achievement in centrifuging for chemical processors.

A difficult problem of separating solids from liquids was solved by AT&M engineers. The installation is a completely electronic-controlled "Hy Par" base-bearing centrifugal. Loading and unloading is automatic. Liquid-solid separation is fast and efficient.

AT&M centrifugals are widely used in Separation, Dehydration, Coating, Filtering, Impregnation and Sedimentation processes.

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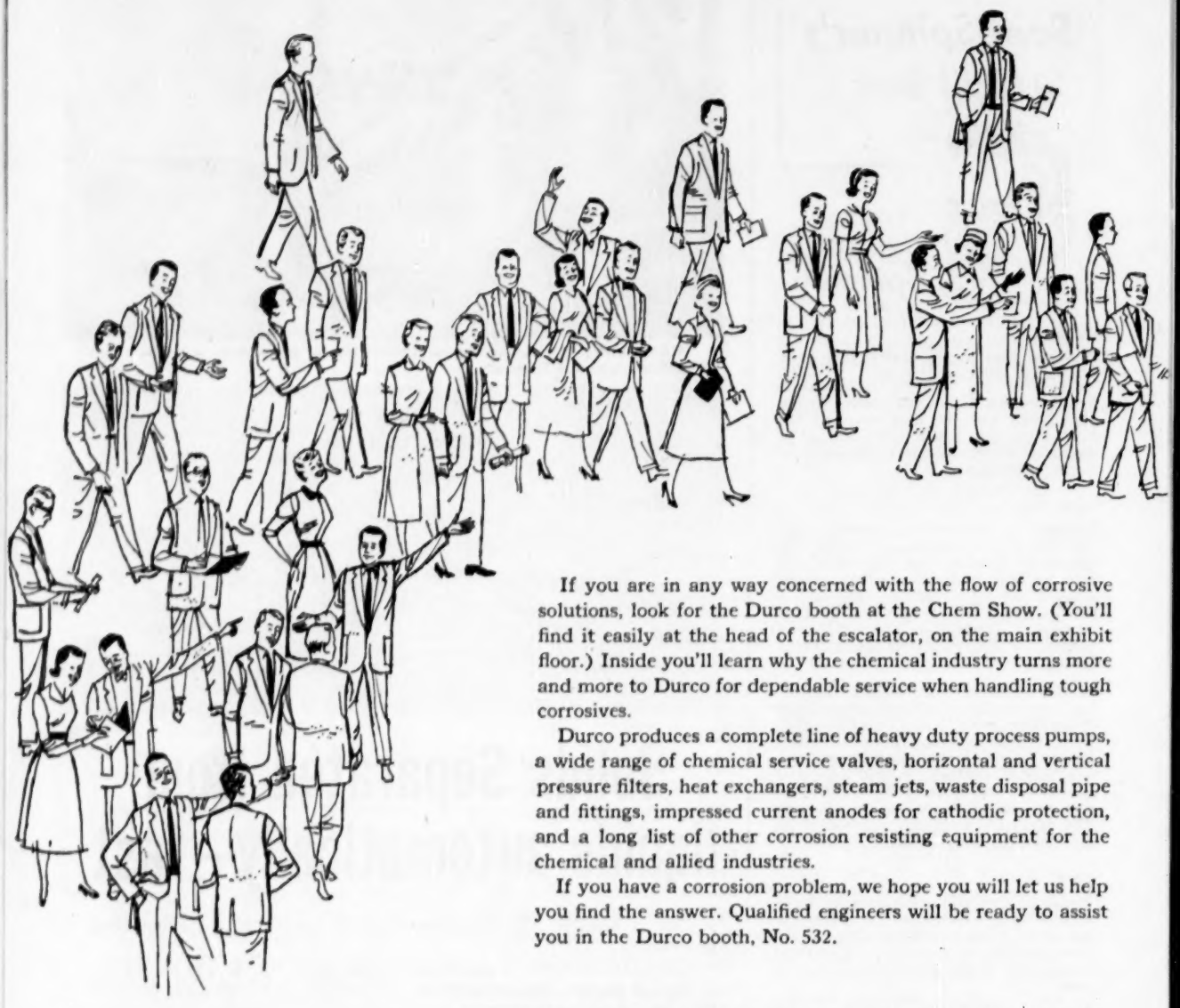
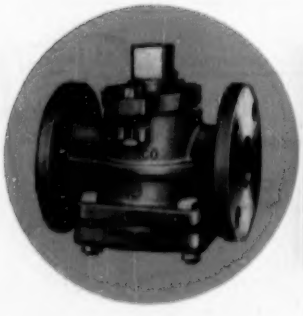


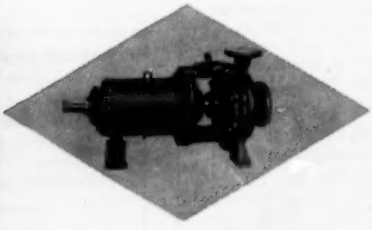
If you are in any way concerned with the flow of corrosive solutions, look for the Durco booth at the Chem Show. (You'll find it easily at the head of the escalator, on the main exhibit floor.) Inside you'll learn why the chemical industry turns more and more to Durco for dependable service when handling tough corrosives.

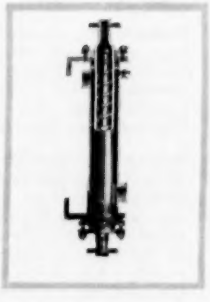
Durco produces a complete line of heavy duty process pumps, a wide range of chemical service valves, horizontal and vertical pressure filters, heat exchangers, steam jets, waste disposal pipe and fittings, impressed current anodes for cathodic protection, and a long list of other corrosion resisting equipment for the chemical and allied industries.

If you have a corrosion problem, we hope you will let us help you find the answer. Qualified engineers will be ready to assist you in the Durco booth, No. 532.

HERE ARE JUST A FEW OF THE







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from the table, which is applicable to all pipe sizes and schedules.

An anchor point should be established between each two expansion elements by clamping solid through a rubber liner. Anchor points should be at fittings or valves, except with expansion loops, where an anchor point would be at the center of the loop. All intermediate support points must allow laterally guided thermal travel of the plastic pipe.

PVC to Metal Joints Not Difficult

In certain instances it is necessary to join a polyvinyl chloride piping system to a metal piping system. In such instances the following techniques should be considered, in order of preference:[3]

- Flanged connections, employing a PVC companion flange, a plainface metal flange having the same drilling, and a soft gasket are entirely satisfactory and most generally recommended.
- Screwed connections, either PVC pipe to metal fitting or metal pipe to PVC fitting, may be used if temperature changes are small, as differential expansion promotes loosening. Metal threads must be clean and perfect to prevent cutting or distortion of the plastic thread. Any thread compound suitable for PVC may be used, and it is advisable to coat both threads. Care should be taken in making the initial engagement to avoid damaging the plastic thread. Make up should only be as tight as with all-plastic joints mentioned previously.
- Cemented joints between metal pipe and PVC socket fittings are possible but rarely used. Certain epoxy-base adhesives will bond the two materials, but they must be carefully selected. The adhesive is prepared on the job, has limited pot life, and a fairly long setting time. This method may have application to joining PVC to thin-wall steel and aluminum, glass, ceramic and thermosetting plastic pipe.

Underground Installations

Where underground installation of polyvinyl chloride piping is required, care should be exercised in order to avoid damage during the laying operation.

Trenches should be fairly smooth and regular so that localized bending stresses are not imposed. When the fluid being conveyed is water or a solution with freezing characteristics similar to water, the line should be buried below the frost line. In backfilling, a layer of loose material, free from rocks, should be placed to a height of 6 in. above the top of the pipe, before proceeding with normal backfilling operations.

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1. B. F. Goodrich Chemical Co., Geon Tech. Service Dept. 55-49, "Machining Geon Rigid Vinyl."
2. Husher, J. L., *Materials and Methods*, June 1954.
3. Personal communication, Alpha Plastics, Inc., Livingston, N. J.

New High-Temperature Titanium Alloys

Two new titanium alloys for high temperature applications have been developed by Mallary-Sharon Titanium Corp., Niles, Ohio.

The first (MST 2.5Al-16V) containing 2.5% Al, 16% V, can be formed, then heat treated to high strength.

Yield strength in the solution-treated condition can be as low as 50,000 psi. to permit easy fabrication. Formed parts are then aged to a tensile strength of 165,000 psi., a yield strength of 150,000 psi., with a 5% elongation. Age-hardened sheets have good short-time hot strengths (yield strength of 100,000 psi. at 800 F.).

The second alloy (MST-821) containing 8% Al, 2% Cb, 1% Ta, is weldable sheet and bar material. It has very high strength at elevated temperatures, with a 200 F. strength advantage in the 400-1,000 F. range compared to other fully weldable titanium alloys available.

Production of the new alloys is on a limited commercial basis at the present time.

Ceramic Coatings Protect Aluminum

Ceramic coatings have been successfully applied to aluminum alloys for the first time, by a process developed at Gulton Industries, Metuchen, N. J.

High temperature applications for aluminum are limited since bare aluminum alloys melt in the range of 1,270-1,375 F. With the new ceramic coating a 0.040-in. thick aluminum sheet with a 0.0015-in. coating withstands a surface temperature of 1,700-1,800 F. for relatively short exposure times (120 min.)

These aluminum alloys in sheets, coated on both sides, will be ½ the weight of comparable steel sheets, and will retain their strength at 1,300-1,350 F. for prolonged periods of time. Coatings are also under development which will resist chemical attack.

Once coated, aluminum alloys can be bent, drilled, punched and sheared without damage to the coatings (lithium chromate, lithium borosilicate, lithium fluoride compounds).

The new coatings can be applied before final alloy heat treatment, thus combining heat-treating and firing in one operation.

Boride Coating Fights Molten Aluminum

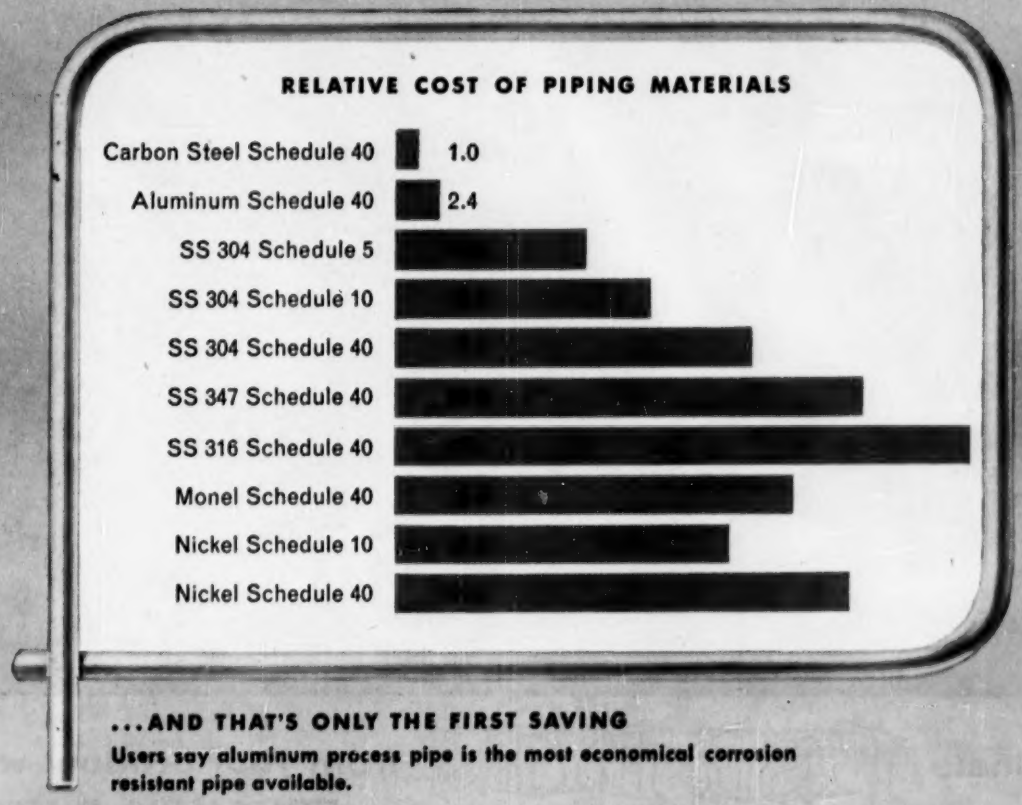
A new method is available for the protection of steel and cast iron parts against attack by molten aluminum—coating with chromium boride.

Developed by the Metallizing Co. of America, Chicago, Ill., the process involves the use of chromium boride rods; flame sprays them in metal spraying equipment.

The coating completely prevents wetting of the coated steel or iron by molten aluminum, and has good oxidation resistance up to 1,800 F.

This process has been used for the protection of thermocouple tubes, heat exchangers and large fabricated parts in contact with molten aluminum.

Here's the cost story on Reynolds Aluminum process pipe



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DECEMBER 1957

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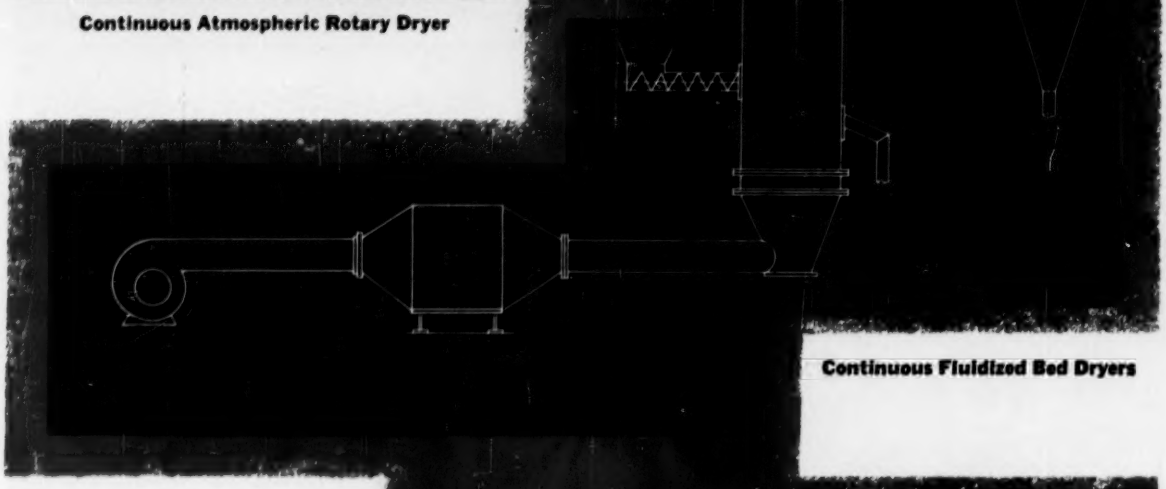

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PEOPLE . . .

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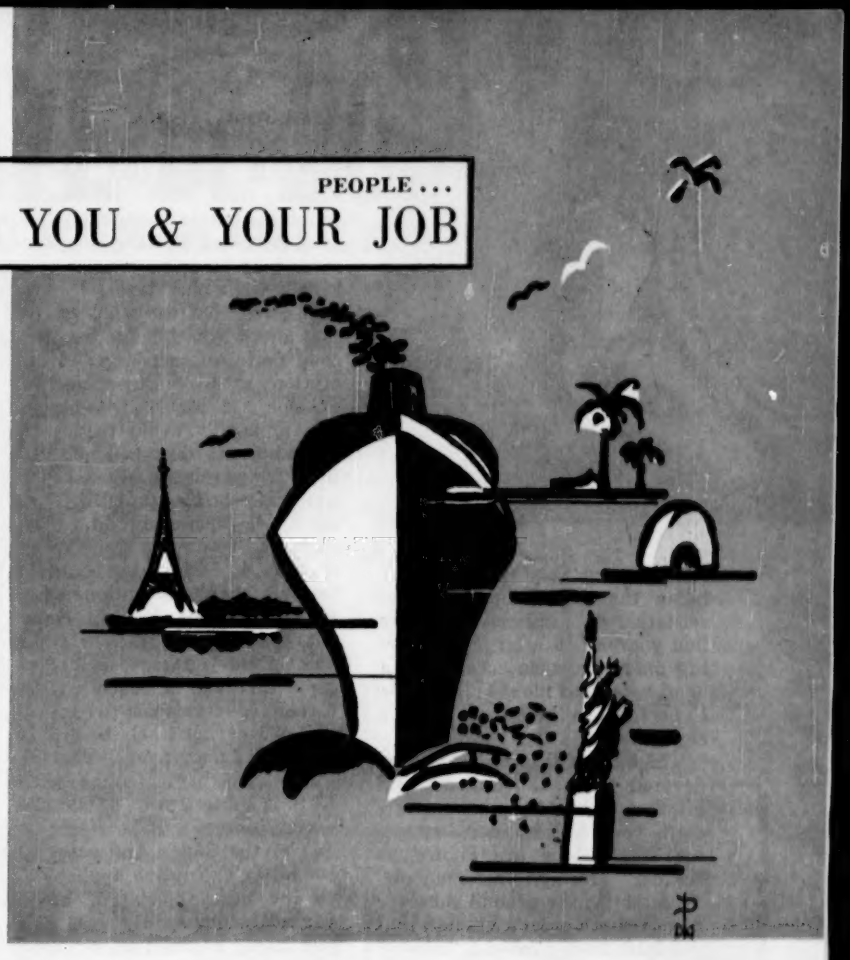

That Job Overseas: Should You Take It?

An engineer with 16 years of experience—more than half of it overseas—takes you into his confidence; shares information that can make or break your career.

Al Boutelle, Plant Engineer, Monterrey, Mexico*

Although I was born and educated in the United States, approximately half my working years have been spent overseas—India, Ceylon, several countries of South America, Canada and Mexico. During these years I have worked for several companies and have acquired first-hand knowledge of the policies of many other companies that operate overseas.

My friends in the U. S. often ask me what it's like to work overseas? What are the advantages and disadvantages? How can they get an overseas position? And what are the little-known facts and intimate secrets that can ease the transition from domestic to foreign employment.

Here's what I now tell them.

* Meet your author on page 324.

Temporary or Permanent?

Assume that you have been offered an overseas assignment. Should you accept? This question—which may be the $64,000 question of your career—is quite comprehensive. But first you ought to differentiate between temporary and permanent overseas assignments.

For a young, single man without ties, a temporary assignment overseas is good experience. Should time outside the continental limits of the U. S. cover more than 510 days, you might benefit from income tax savings. However, it's difficult to establish *"bona fide* foreign residence" on a temporary assignment.

Salaries are usually high, but living conditions may be poor. On construction jobs you may live in barracks and eat at the company mess. Because of the monotony, high salaries are the rule and it's possible to return after 18 months with a sizable bankroll. But the monotony, the constant encounters at work and at play with the same people, the lack of variety in locale or companions often prove to be distasteful.

However, other temporary assignments in different geograph-

ical locations may result in your being the only company representative on location. You may find yourself in a large city, living on an expense account in a good hotel and more or less able to perform to the utmost of your capabilities.

The bulk of this article will be devoted to the advantages and disadvantages of permanent foreign work. With many companies these jobs are known as "career" foreign assignments. To establish the ground rules for our discussion, let's assume that you have been offered a "career" overseas assignment by your company; that you are married with several children; and that you are 30-40 years of age.

You are technically capable; personable to the extent that you have always enjoyed your work and co-workers; and have been able to live within your income in your present location.

Six Distinct Advantages

There are six distinct advantages of a permanent overseas job. They are:

- Lower income taxes.
- Higher pay.
- Possible lower cost of living.
- Broader education.
- Earlier retirement.
- Opportunity for advancement.

If you can establish "*bona fide* foreign residence" or remain outside the U. S. for 510 days, you are not subject to income tax on your earnings within that period. For more details, see Sect. 911 (a) of the Internal Revenue Code.

This *may* mean that your income taxes will be lower. Usually the U. S. income tax rate is higher than that in foreign countries but in some countries, such as Great Britain, the local taxes may be as high as or even higher than U. S. taxes.

If you have the kind of job that allows you to move from one country to another at your discretion (sales engineering, for example) it may be possible for you to legally avoid paying all income taxes. You can establish bona fide residence in one of the countries to eliminate U. S. taxation (or remain abroad a minimum of 510 days). Then by remaining in each of the countries for less than the minimum taxable period—or leaving before your income has reached a taxable level—you may legally escape taxation in each of the foreign countries you cover.

However, as a U. S. citizen, your income from whatever source within or without the U. S. is subject to U. S. taxation, except as covered in Sect. 911 (a) of the Code. And note that the latter exemption applies only to the first $20,000 of annual earned income.

Because of the limited number of people who are willing to live abroad, and because of the disadvantages to be discussed later, the rate of pay for overseas jobs is generally from 25 to 100% higher (depending on geographical location) than pay for the same position in the U. S.

Cost of Living Varies

In some places the cost of living may be much lower than in the U. S. Servants are not considered a luxury, but are the normal way of life. In some cases the company subsidizes a portion or all of the expense of housing, club memberships, schooling or it may give a cost-of-living bonus.

The philosophy here is that if the cost of living in a particular area is not lower than in the U. S., the company tries to grant adjustments. The reason is obvious: the high cost of labor turnover caused by dissatisfied employees returning home.

Depending upon location, there may be educational advantages for the younger members of your family in learning several languages fluently, and in visits to nearby geographic historic landmarks.

Many companies permit an overseas "career employee" to retire at age 55; or they grant a retirement credit which reduces the retirement age according to the time spent overseas and the areas involved. For example, 20 years in the tropics may count as the equivalent of 25-year's service in a temperate zone overseas and as the equivalent of 30-year's service in the U. S.

Advancement Comes Quickly

Perhaps the greatest advantage of overseas work—apart from the financial aspect—is it offers greater opportunities. Stateside personnel assigned to a foreign plant are comparatively few in number, so that the responsibilities of each are correspondingly greater.

An engineer, whose responsibilities in a U. S. plant might be confined to piping design, may find that overseas he is responsible not only for design but also for purchasing, inspection, installation, maintenance and administration.

For a versatile engineer with a good basic education and the ability to learn quickly, foreign work offers an opportunity to advance to the utmost of his capabilities. Each day brings new problems and presents new challenges.

Just as Many Disadvantages

Naturally, there are disadvantages to living and working overseas. Some of them are implied in the preceding paragraphs; we'll discuss others below. But it should be understood that conditions change from area to area and from one employer to another, so that no hard and fast generalities apply.

You'll want to consider these factors:

- Climate and living conditions. Obviously, if you dislike hot weather and love winter sports you'll be happier in Labrador than in Saudi Arabia. Many people cannot live and work in the tropics. You may find housing, sanitation and food to be such that the job isn't worth keeping for any amount of money. Diseases such as malaria and dysentery are exceedingly

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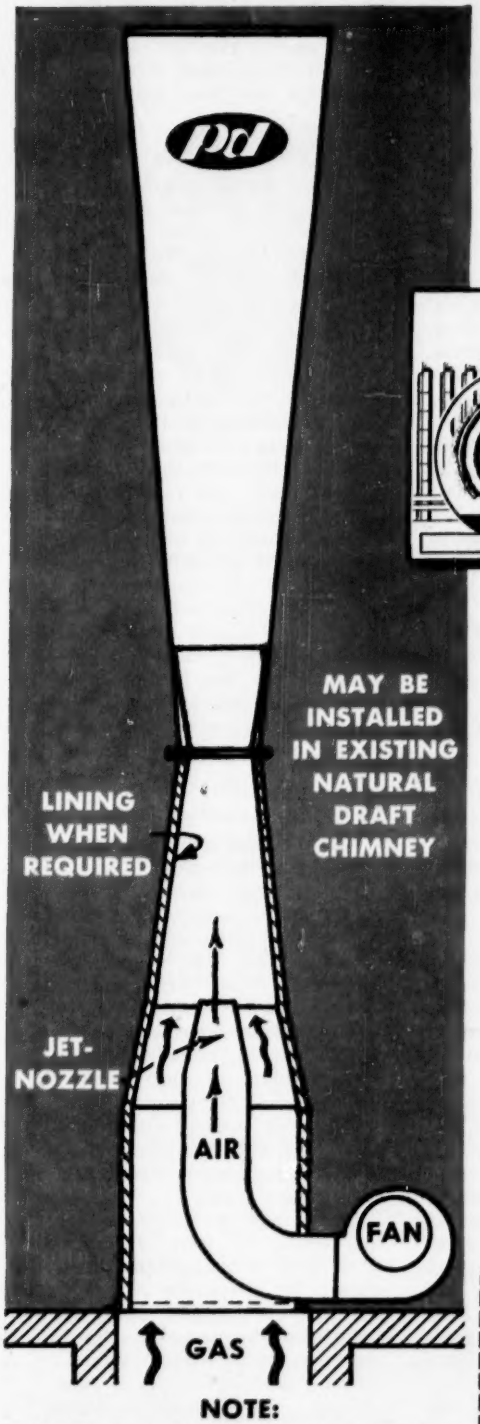

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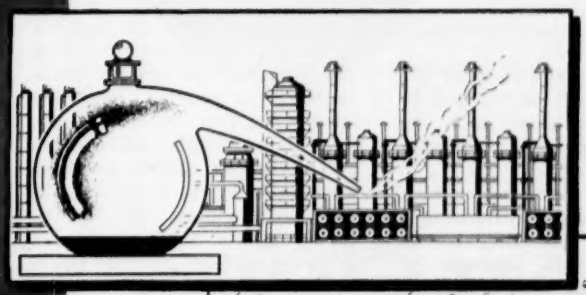
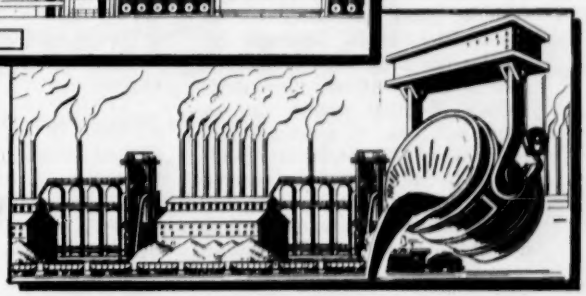


FOR CHEMICAL PLANTS

FOR STEEL MILLS



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common—and hard to avoid—in many locations.

Generally, on the rougher assignments, you'll be warned in advance. Sometimes this is phrased as "family accommodations not available."

• Inability to save earnings. Few nations of the world have a "middle class" as extensive as the United States. In many localities the population is divided into a comparatively few individuals of great wealth and an enormous mass of people of extreme poverty by Stateside standards. As one of the management team you will be obliged to live like a boss is expected to in that locality, even though the expense involved may be considerably higher than you would normally incur if left to your customary set of values.

Your wife may have done her own shopping, the family laundry, and tended the children back in the States, with domestic help limited to an occasional babysitter. Overseas you may find that you are obliged to hire a cook, a nursemaid, a laundress and a number of housemaids, houseboys, gardners, etc. You'll have to live in a "good" or "approved" section of the town and maintain a house as befits your position as one of the local top management.

The result is that a new factor is introduced into your budget. You must live up to your imagined position with corresponding expenses for housing, servants and entertaining. It's true that servants are cheap—from $10 to $20 each/month—but the total expenditure may run to $100 or more/month. The $20,000/yr.-man who had the same way of life in the States may find that his living costs have declined; but the $12,000/yr.-engineer finds that he now must live like the $20,000/yr. plant manager and his cost of living has increased.

• Schooling for children. Some countries have English or American schools available, but it will cost you several hundred dollars/yr. for each child, which may come as an unpleasant surprise if you have been accustomed to free public schools.

• Lack of roots. This disadvantage is especially applicable to those who are subject to frequent reassignment. They have a number of acquaintances in many countries but few friends and few "roots." As the years pass, friends and relatives in the United States decrease. Eventually one is a stranger in one's own country. The "roots" are stronger and more numerous in one's adopted country—particularly if you have married abroad.

• Limited recreational activities. In most places in the United States you're able to take advantage of inexpensive recreation: national parks, public golf courses, swimming pools or beaches, hunting, etc.

Few locations abroad can match these possibilities. If you like to golf and swim it will be necessary to join a club, which commonly costs from $1,000 to $5,000 initiation fee plus annual dues and assessments.

Of course, in some dream assignments like Rio de Janeiro or Montivideo (with miles of beautiful beaches, ocean fishing, theaters, night clubs, etc.) recreation is no problem. However, in many locations recreation may be limited. And it is always more expensive than in the States.

Coupled with the lack of recreational facilities, and the ensuing boredom, the prevalence of servants gives rise to a peculiar problem. Many American wives overseas have too much time on their hands, and too few opportunities for recreation. As a result, some fall into the habit of lounging at the country club to pass the time with the aid of gin and tonic. A few years of this can be disastrous.

Boredom and limited recreation may contribute also to homesickness. You may eventually get to the point where you are ready to leave for home at the first opportunity. For this reason, overseas assignments usually specify that the company pays return passage only upon completion of the contracted period.

A Road With No Return

Perhaps the most serious disadvantage of an overseas career is that if you should have to change your plans for reasons of illness, or personal family reasons, there is usually no comparable place for you in the home plant back in the States.

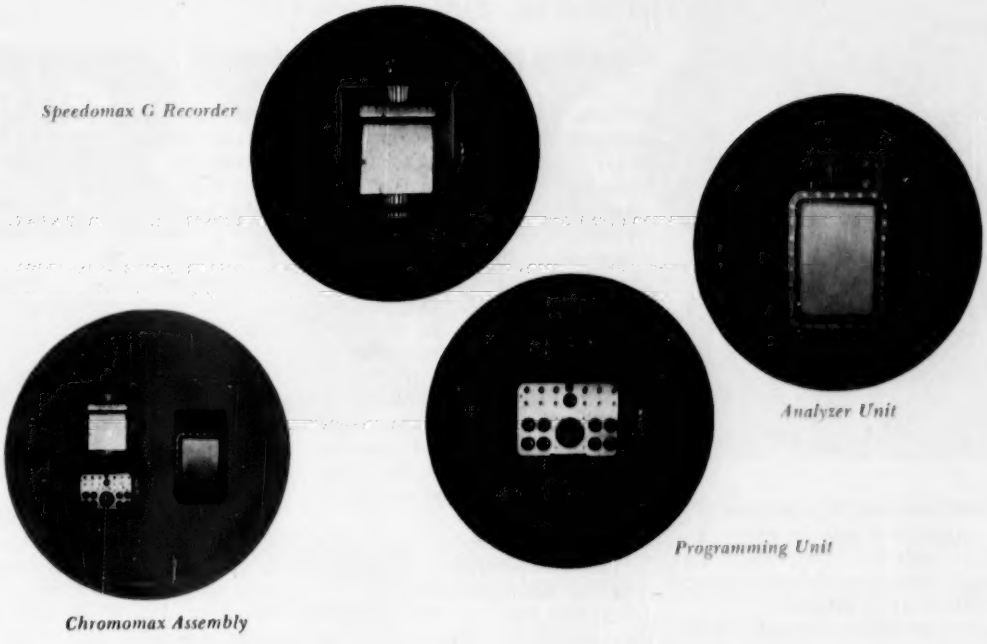
While you've been overseas—probably advancing more rapidly than you would have at the home plant—others have been climbing the ladder. Because you now wish to come home, you can't expect to displace those who have been plugging away at home. Generally, you'll be able to come back to a job with the same company; but unless you have had an unusual record of success overseas (and it must be well-publicized at the home office) you'll find that the job back home is going to be pretty small compared to the one you left overseas.

Conditions of Employment

What are the usual conditions of overseas employment?

The company normally agrees to transport you, your family and your personal effects overseas and back. The concept of "personal effects" varies widely, but with most companies it is taken to exclude pets. Some go as far as to exclude pianos, garden furniture and automobiles. It's customary for the company to pay customs duties and other fees, and to handle the details of the shipment through its export department.

If you have any control over the details of your shipment, avoid at all costs an itemized list, except for insurance coverage. For customs purposes, it always facilitates clearances to simply list "one trunk, containing *used* personal effects." Upon arrival abroad, look up a customs broker. Let it be known that you understand the local custom of *bak-*



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sheesh, mordida, "greased palm" or whatever it may be known as locally, and that your main desire is that your shipment clear promptly upon arrival.

The customs broker will handle the details and you'll have your belongings installed in the house long before anyone who itemized his shipment in detail.

In many countries bribery is an acknowledged practice. It carries none of the stigma associated with the practice in the United States. But it's easier (unless you are fluent in the language and are thoroughly familiar with that location and its people) to let a local customs broker make the arrangements.

Automobiles are a matter for individual negotiation between you and your company. If you are going to need one, have it clearly understood as to the availability and conditions of use of any company cars. You may be told that there is no need for a car of your own, as the company provides a car for the use of local management. Upon arrival, you may discover that the company car is available to you only during business hours—if at all—and that the rest of the time it's considered the personal prerogative of the plant manager.

To and from work, weekends and holidays you may have to provide your own transportation.

Resist all suggestions that you sell your car in the States before leaving, and buy another car when you arrive overseas. With the exception of some European countries, cars cost from two to three times as much overseas as in the States. And in some places you can't get a car even at those prices. If your company will pay the difference, have it clearly understood whether there are any limitations on cost and whether the company retains an equity in the car.

You may discover after purchasing a car overseas with company assistance that they are retaining an equity in the car, collectible when you sell it. Meanwhile, you are paying at your own expense for insurance (several hundred % higher than in the States) and repairs (ditto) to maintain the company's equity in good condition.

How to Get a Job

The best overseas job is the one for which the company has requested your services; not the one which has been granted at your request. As we'll discuss later, overseas jobs are subject to bargaining to a much greater extent than are domestic positions. Your bargaining position is best when they come after you.

To begin with, when you approach the boss or the personnel manager with the news that you are ready to take off for Lower Patagonia at a moment's notice, there is an immediate reflection upon your judgment in that you haven't the common sense to know when you're well-off. In younger engineers, fresh out of college, such whims are tolerated and even expected; but if the mature engineer with a number of years of service does likewise, his judgment is suspect.

To a lesser extent, the same applies when you reply to an advertisment seeking men for overseas assignments. If you have not worked abroad previously, your motives will be subject to considerable perusal.

The preceding paragraphs do not mean that you should sit back, wait and hope that someday an overseas job will come looking for you. Far from it. You can take positive action right now.

What You Can Do

If you really want to get ready for that overseas job, here's how you can prepare:

- Learn a language. Language fluency is often one of the prime requisites for an overseas position. Get your wife to learn the language, too.
- Familiarize yourself with the area of your choice.
- Sell yourself. After acquiring your knowledge of the language and the area, proceed to publicize yourself in an indirect manner. Let it be known by your superiors—and to the sales manager—that you speak Portugese, for example, and will be glad to lend your services in showing visitors from Brazil or Portugal or Macao through the plant.
- Change your employer. In the event that your present employer is not expanding abroad, you are faced with the necessity of changing jobs.

Watch These Points

Much advice is implicit in the preceding paragraphs. Several other points are worth considering.

Passports, Visas, etc.—With the exception of customs permits and export shipment, the best rule is to *do it yourself*. There is nothing complicated about obtaining a passport and the necessary visas. The requirements for the latter vary from country to country and with the type of visa desired. But in general you will need:

1. A plentiful supply of photographs of passport size.

Next Issue: "Dear Boss" Letters Pinpoint Plans

I'm gonna sit right down and write my boss a letter; and tell him what we ought to do during the next six months. Sounds a bit presumptuous, doesn't it? But that's exactly what one chemical company is now asking its professional employees to do on a regular basis. They call it the "semi-annual letter" program and it pays off in planned creativity, more effective use of technical manpower, cost reduction and accelerated professional development. In our next issue, You & Your Job will detail this program for you and discuss its probable impact on engineering management.

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2. A letter from an officer of your company to the Consulate of the country concerned, stating the purpose of your visit and certifying that your company guarantees you will not become a public charge while you are there.

3. A letter from the police in your previous place of residence certifying to your good character and lack of criminal record.

4. A certificate of vaccination against smallpox, preferably on the United Nations International Public Health Service yellow card.

5. A doctor's certificate of your good health. Generally it's simpler to ask the Consulate to recommend a doctor. Some consulates keep a supply of the business cards of their favorite doctor. Enough said.

In short, always get your own visas whenever you can, even though your company may have a "specialist" in such matters. The "specialists" are sometimes concerned with making sure everyone realizes the complexity of their specialty. Having obtained over 150 visas for myself without incident, it appears that my only difficulties have arisen when my employers insisted on letting the "specialist" handle the matter.

One time, before I knew better, the company specialist obtained a permanent visa for a proposed six-week visit to Brazil. "Permanent," I was later told, sounded like a better visa to have than "tourist" or "transit." When I arrived in Brazil, I spent three weeks being fingerprinted, registered and photographed at various places, ultimately acquiring an identification folder which entitled me to live as a Brazilian to the end of my days. When it came time to continue my trip, two weeks were spent getting income-tax clearance for an exit visa.

The proposed six-weeks visit had been extended to 12 weeks. From that time on, I obtained my own visas.

Method of Payment—If possible, specify that you be paid in dollars deposited to your account in your Stateside bank. The next-best policy is to have your salary specified in dollars, even if paid in local currency.

In 1946 a large chemical company sent a number of families to Argentina. At that time the Argentine peso was 4 to $1. In less than four years the free-market rate on the peso had gone to over 14 to $1. If these families had tied their incomes to the U. S. dollar there would have been no problem. But this was not the case and at the end of 1950 only 6% of the group could afford to remain in Argentina and these were top employees with bonus plans.

Another point to consider is whether free convertibility exists for the currency in which you will be paid. If not, how are you going to obtain dollars to pay your life insurance, children's tuition, parent's support or other expenses you may have in the U. S. while you are overseas?

Get It in Writing

If possible, obtain a contract or memorandum spelling out the details of your overseas assignment. No reputable company can object to putting in writing what it offers verbally. This will save much misunderstanding, since memories are, after all, only human.

Take company-supplied information with a grain of salt if it seems overly optimistic. It is better to dig out your own information. The U. S. Diplomatic Service has periodic compilations of costs in various overseas locations to establish a cost-of-living index in comparison with Washington. This index is not particularly applicable to civilian living but it is better than no index at all.

Make sure that the company spokesman who describes your assignment has actually lived there himself, and recently. Some company "brass" who visit their overseas plants spend most of their time in air-conditioned hotel rooms, eating in the town's best restaurants, holding long-weekend "conferences" at the nearest resort area and generally enjoying the best that the country has to offer at company expense.

This does not give the traveler a particularly accurate idea of what normal life is like in that country.

As a final caution, be sure that the company policies actually apply to the location to which you will be sent. Some companies have different rules for different countries—and for different locations in the same country (Monterrey with its 110°-heat, water shortage and electricity blackouts is not the same as Mexico City with its eternal-spring climate and cool nights). It is disappointing to discover that the company policies that sounded so attractive are not the same as those actually in effect where you are being sent.

That overseas job can be exciting and rewarding. But be sure that you are aware of all the problems. Then you'll have a much better chance of bargaining for those vital concessions which make all the difference between an enjoyable opportunity and an unendurable ordeal. Good luck.

SALARIES

. . . *An ASEE Follow-up*

When the EJC salary survey was issued earlier this year, the data for engineering teachers were turned over to the American Society for Engineering Education for further study by William H. Miernik and Morris A. Horowitz of the Bureau of Business and Economic Research at Northeastern Univ.

Results of the study are now available at 25¢/copy. The two major conclusions:

• The average engineering teacher in American colleges and universities earns a salary of $6,634/yr., or $550/month. He adds consulting and other engi-

KEEP IT CLEAN by Phil Tration

"On-the-job" blood purification is not a recommended use for Dollinger Staynew Filters . . . but who knows, maybe our cartoon will start a new trend.

After all, everyone in industry today is looking for new and more efficient ways of doing things. And, when it comes to new ideas in filtration, Dollinger is ready, willing, and able. Whether you want to protect machines or processes from damage caused by dust, dirt, oil, grease, or other foreign matter, Dollinger Engineers will provide a Staynew filter to do the job efficiently and economically. Chances are your filtration problem has already been solved and there is now a *standard* Staynew Filter to handle it.

STAYNEW MODEL ELS LIQUID FILTER

Practically any liquid can be successfully filtered with these Dollinger Filters. Their world-wide use on hundreds of different jobs is adequate proof of their versatility. Any filtering material is available for every problem regardless of temperature, pressure, or efficiency desired. Filter bodies are available in steel, stainless, monel, herculoy and other non-corrosive metals.

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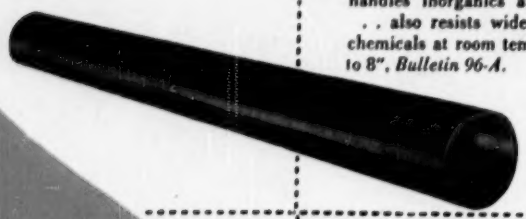
FOR HOT CORROSIVES:
ACE TEMPRON

Heat-resistant nitrile hard rubber pipe handles inorganics at 250-275 deg. F. . . . also resists wide range of organic chemicals at room temperature. Sizes 1" to 8". *Bulletin 96-A.*



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For profitable runs you must keep equipment "on stream" full time with no corrosion shut-downs. Protect your profits with Ace piping, pumps, valves, and tanks. Many rubber and plastic materials . . . backed by a century of chemical experience. Get facts today from American Hard Rubber Company.

MIGHTY MIDGET
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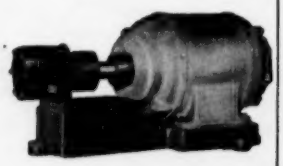

Jabsco neoprene-impeller pump made of Ace hard rubber outlasts, out-pumps anything in its pressure, size and price class. Capacity from 15 gpm. at 22 ft. head to 5 gpm. at 72 ft. head. *Bulletin 97-A*

SENSITIVE, BUT KEEPS YOUR HEAD

ACE Darling Swing Check Valve . . .

lined with Ace hard rubber for the best in corrosion resistance. Large, straight-through flow areas. Sensitive to slight pressure differential. Non-slamming. Sizes 2" to 24". *Bulletin CE-52.*

TOUGH ACE-ITE PLASTIC PIPE

General-purpose moderately priced rubber-plastic pipe handles most common chemicals to 170 deg. F. . . . except few strong acids and organic solvents. Tough, odorless, tasteless. Rigid pipe ½" to 6". *Bulletin 80.*

ACE processing equipment of rubber and plastics

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neering work to bring his total annual earnings to $8,862.

• He earns more if he teaches in a privately endowed institution than in a public institution, and he earns more on the Pacific coast than anywhere else in the nation.

AN ACADEMY

. . . *In Your Future*

We don't know how high up the executive ladder you may have set your sights; but whatever your ultimate goal, another stepping stone to the top is now ready for you. The American Management Assn. has just opened its new Academy of Advanced Management at Saranac Lake, N. Y.

The 90-acre, 60-building academy is located in the Adirondack Mountain region of New York State on the site formerly occupied by the famous Trudeau tuberculosis sanatorium.

In his remarks at the dedication ceremonies, Don G. Mitchell, chairman of the board and president of Sylvania (at right in photograph above), predicted, "The need for the academy is so great and its future appears so assured that I would like to predict that within the next few years management men from all over the world will not only be attending this academy but will consider that attendance here is a prime requisite to attaining and holding top management positions."

Another prediction, in this case by Lawrence A. Appley, president of AMA, (at left in picture), is that "this academy will have its greatest impact

upon thousands who will never see this place, the employees of the companies whose executives will be attending its meetings."

EXECUTIVES

. . . *Too Busy to Rest*

Company complaints that top executives don't take as much time off from their jobs as they should, appear to be substantiated by a recent American Management Assn. survey of executive vacation practices.

Of 96 randomly selected members, 46 reported that they used less than the total amount of vacation time allocated to them by their companies last year. Four took no vacation at all.

"Too busy"—or some variation on this theme—was the most common reason the survey respondents gave for not taking all their vacation time. However, one interesting reply was. "Had to go to Europe on business—came back by boat, which was a vacation in a way." And another, "Couldn't go on vacation because of shortage of other executives."

ABOLISH

. . . *School Vacations*

The directors of the American Society of Civil Engineers have decided that summer vacations for students are unnecessary. In accepting a report of ASCE's committee on engineering education, the directors went on record as being in favor of a 12-month academic year to help ease the engineering shortage.

According to Louis R. Howson, newly elected president of ASCE, "The present school year with three months of summer vacation is certainly inefficient. Is it logical for us to have educational plants idle for one period of the year and then overtaxed during the balance of the year?

"If we can keep these plants open throughout the year, it is obvious that we can turn out more trained graduates for employment in the professions where the need is so critical."

STAYS TOUGH AT SUB-ZERO TEMPERATURES

ACE PARIAN . . . odorless, tasteless, rigid polyethylene. Best chemical resistance of any plastic at room temp. except to acetic acid. Excellent impact strength at sub-zero temp. Rigid pipe ½" to 2". *Bul. 351.*

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Rubber-lined by ACE 2-layer system

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Now eleven ACE Materials to STOP CORROSION

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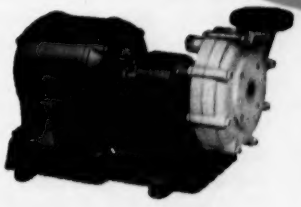

ACE "WAM" . . . THE FINEST
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On job after job, this 80-gpm. centrifugal pump has earned highest praise. Hard rubber casing and impeller, Hastelloy C shaft. Handles nearly all corrosives. Mechanically simple, trouble-free. *Bulletin CE-55.* Larger ACE pumps available.

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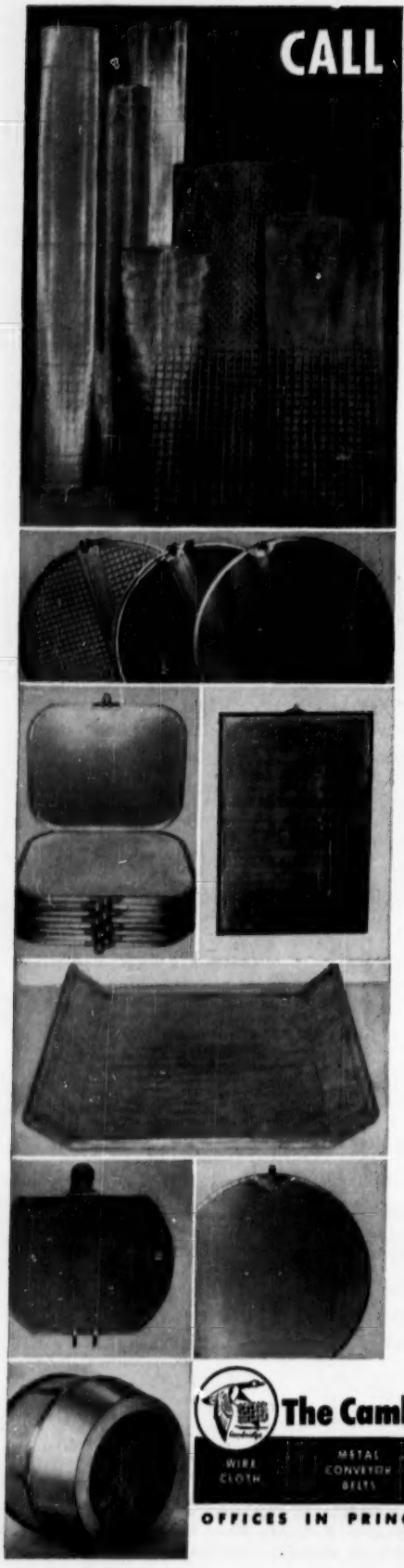

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PEOPLE . . .

TECHNICAL

Nuclear Processing

NUCLEAR CHEMICAL ENGINEERING. By Manson Benedict and Thomas H. Pigford. McGraw-Hill Book Co., New York. 594 pages. $9.50.

Much of what passes for "nuclear" engineering is nothing more than applied chemical or metallurgical engineering.

The voluble group of people who believe this—and your reviewer is a member—have just been handed some powerful campaign literature with the publication of this book. For here are details on how chemical engineering processes produce nuclear materials.

The title of the book is at best meaningless, and very probably misleading. It is mainly a process book, and this fact should have been emphasized in a title such as "Nuclear Chemical Engineering Process Technology."

Messrs. Benedict and Pigford have relied heavily on previously published information—hardly surprising since most of the processes described were developed with AEC funds.

But if you are looking for nuclear process information, this book should save hours or days of searching through the literature. This literature contains a great amount of process information, but alas, it is widely scattered through technical magazines, AEC publications, UN publications, pamphlets, speeches, etc.

In "Nuclear Chemical Engineering" you'll find chapters, with references, on nuclear reactions, fuel cycles, production of uranium, zirconium, thorium, beryllium, solvent extraction of metals, separation of reactor products and isotope separation.

However, you'll find very little on ion exchange as applied to nuclear processes. And you'll have to go somewhere else for information on chemical engineering as applied to nuclear reactors. Also, some sections are already outdated—there is no

BOOKSHELF

J. B. BACON

The book is well planned. mention of the new sodium reduction process for producing zirconium.

Its one prime use should be as a text for a college course. But the book should be useful to all chemical engineers interested in nuclear processing.—RBN

Recent Knowledge

ENGINEERING PROPERTIES AND APPLICATIONS OF PLASTICS. By G. F. Kinney. John Wiley & Sons, New York. 278 pages. $6.50

Reviewed by Allan L. Griff.

This book presents, in an easy-to-read style, the vast amount of information that comprises current plastics technology. The field of plastics has grown remarkably fast, and new techniques and materials are constantly being developed. This book is the most recent collection of plastics knowledge that we have, and should help anyone with a basic scientific background to get a good over-all grasp of today's plastics industry.

The book is well planned. First, each of the major plastics (and some minor ones, too) are described chemically and physically. Important uses and chief fabrication methods are given, as well as the key properties that make the plastic useful. These descriptions of the plastics take up more than half of the book.

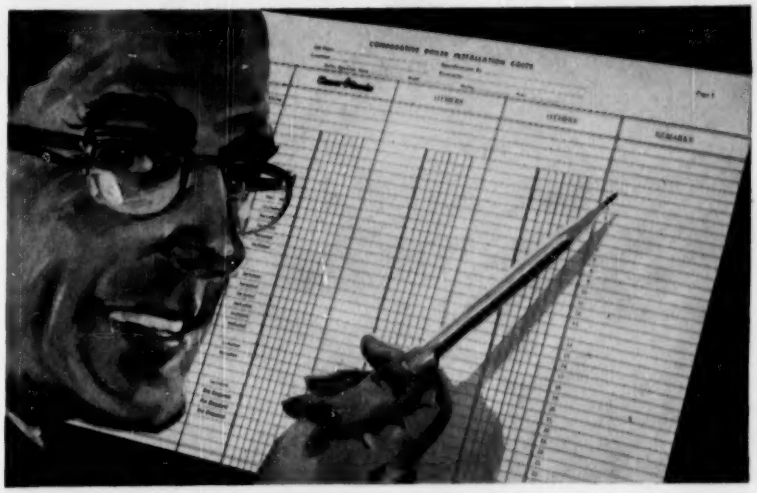
Next is a brief description of the common fabrication methods, independent of any one material.

Then there are sections on the various properties of plastics—mechanical, thermal, optical, and electrical. This is a most valuable section, telling what can and cannot be done with plastics, in engineering terms. It helps make application of plastics a scientific process.

Finally, there is a chapter on plastics chemistry, which is a condensed review of general or-

Before you buy any boiler

compare quoted prices with REAL COSTS



New Cleaver-Brooks cost analyzer clears "quotation" confusion — reveals ALL costs

Get *all* the costs... the *real* costs ...down on paper before you recommend or specify a boiler to your clients. On many boiler installations "quoted prices" seldom agree with the total costs, as you may have learned. This is frequently the case with so-called "built-up" boilers assembled on the site.

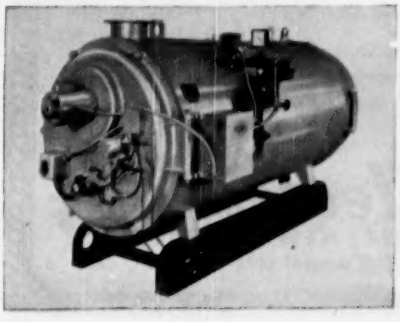
Cleaver-Brooks' cost analysis enables you to compare all material costs (boiler, steam trim, burner, refractory, controls and other equipment) and installation labor costs. You'll know the "real costs" on the complete installation before you start.

Real eye-opener

The figures you'll see may be startling. In most cases the cost analysis proves a Cleaver-Brooks costs *less*. On-job time is drastically reduced because Cleaver-Brooks packaged units are fully assembled, ready to install. Cleaver-Brooks boilers give you more in performance, too . . . each boiler is fully fire-tested at the factory under load, tuned to peak economy. Starting service and on-the-job operator training by authorized field engineers further decreases your over-all costs.

Contact your Cleaver-Brooks agent

Once you add up all the benefits of a Cleaver-Brooks "one-cost" package . . . the proved trouble-free economy of exclusive four-pass, forced-draft design, you'll find it pays over and over to analyze costs carefully before you buy. See your Cleaver-Brooks agent for details or write Cleaver-Brooks Company, 345 East Keefe Avenue, Milwaukee 12, Wis., Dept. P.



Choose from 19 sizes, 130 models, 15 to 600 hp. Oil, gas and combination oil/gas fired — steam or hot water for heating or processing.

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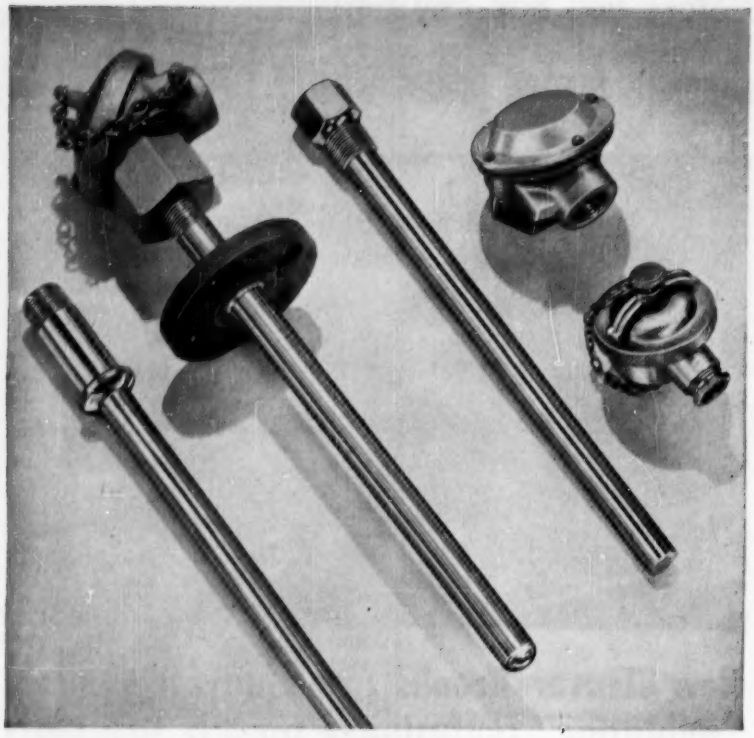

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SADDLE BROOK, NEW JERSEY

In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

ganic chemistry, slanted towards reactions useful in plastics.

Considering the rapid rate of change in the plastics field, this book is quite complete, mentioning such recent developments as polypropylene, linear polyethylene and synthetic "natural" rubber.

Diagrams and graphs are plentiful and well chosen However, the book contains an unusually large number of typographical errors. Some are obvious and harmless, but a few occur in structural formulas and property tables, and could easily mislead the reader.

"Engineering Properties and Applications of Plastics" is a valuable addition to our technical literature. Its minimum of technical jargon and its graphic style (for example: pellet sizes range from aspirin tablets to hockey pucks) make it easy reading for a large audience. It would be a good textbook for a college course in plastics technology. Others who should find this book useful are those who are considering entrance into plastics from either the business or the technical end, and people who work in one area of plastics who need occasional reference to other areas or who wish to broaden their plastics outlook.

Toxicological Properties

INDUSTRIAL TOXICOLOGY. By L. T. Fairhall. The Williams & Wilkins Co., Baltimore. 376 pages. $10.

In this compact reference book, the author presents information on the toxicity of many industrial chemicals. This second revised edition contains references to current literature as late as 1955 from world-wide sources.

In the introduction, the author discusses the methods and techniques of experimental toxicology, chemical constitution and physiological response. He also stresses an element of caution in the meaning of toxicity and in "attempts to evaluate the toxicity of a given substance by any mathematical relationship. . . ."

The descriptive material is divided into two parts which are inorganic substances and carbon

compounds. In addition to the many well-known compounds, the carbon section contains data on organic substances used as insecticides, fungicides or germicides.

The table of contents is alphabetically arranged for each section and makes for ease in locating specific compounds.

Under each substance the author describes the characteristics of the substance, its industrial uses and toxicity of the material. Information on analytical techniques for measuring concentrations of these substances is also given.

A very desirable feature is the listing of the references at the end of each topic. This arrangement permits rapid identification of a reference if the reader wishes further information.—SD

Versatile Epoxies

EPOXY RESINS, Their Applications and Technology. By Harry Lee and Kris Neville. McGraw-Hill Book Co., New York. 305 pages. $8.

Reviewed by R. F. Sellers.

From the ever growing volume of chemical literature, the authors have taken the most representative works pertaining to epoxies and, drawing upon their own experience, they have prepared a reasonably comprehensive guide to the relatively new field of epoxy resins and their applications. The main theme of the book deals with the identification of the various resins, hardening agents, modifiers, etc., and how they may be used in a great many applications.

Approximately one-half the book is devoted to a discussion of epoxy resin types and characteristics, curing mechanisms and the various hardening agents and modifiers. The more important resins, curing agents and modifiers are discussed in some detail, particularly with respect to handling characteristics, types of cure and typical properties which may be expected from their use.

The remainder of the book is devoted primarily to the successful application of the principles of resin technology in some typi-

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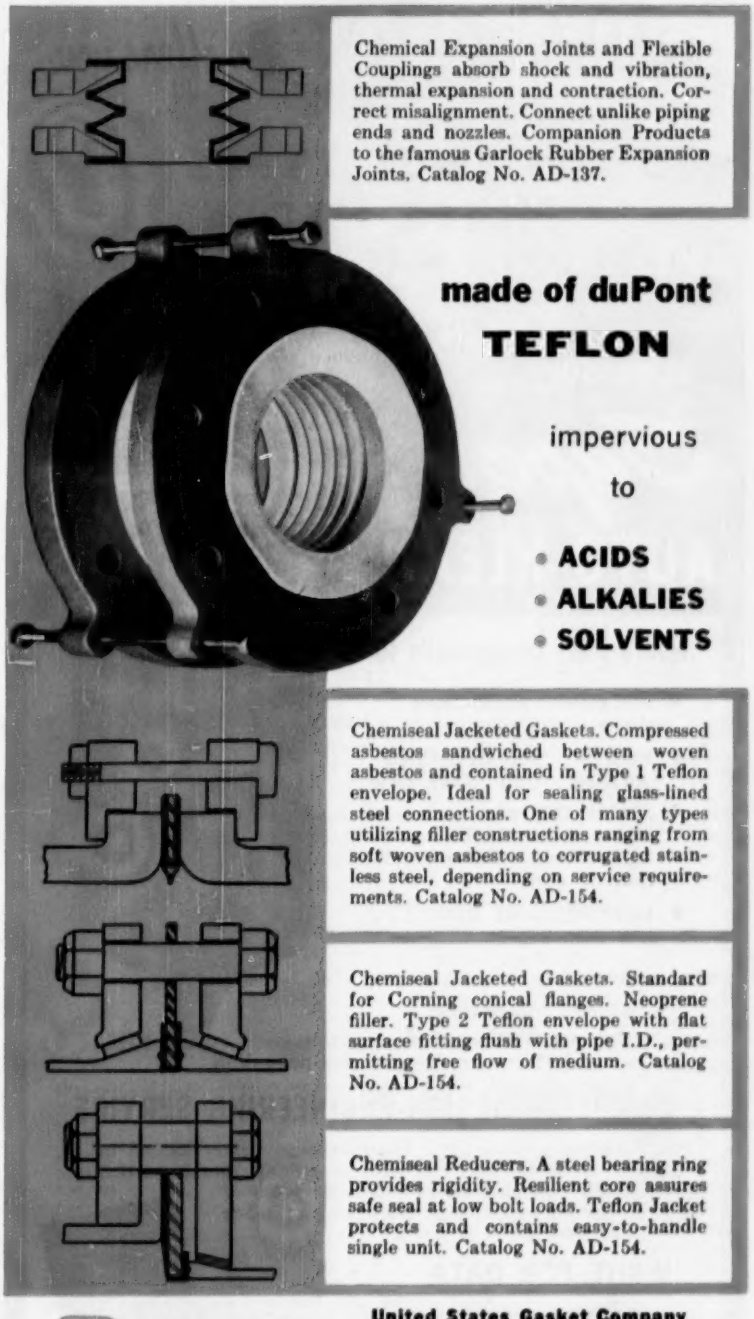

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Chemiseal Jacketed Gaskets. Compressed asbestos sandwiched between woven asbestos and contained in Type 1 Teflon envelope. Ideal for sealing glass-lined steel connections. One of many types utilizing filler constructions ranging from soft woven asbestos to corrugated stainless steel, depending on service requirements. Catalog No. AD-154.

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cal examples. One chapter describes casting, potting, encapsulation, sealing and lightweight foams. Separate chapters deal with the use of epoxies in adhesives, laminates and coatings. Finally, a short chapter presents general tips on handling methods and safety precautions.

The book contains typical formulations, curing cycles and properties designed for many specific end uses with particular emphasis on the various considerations which led to their selection. Using the information given, it should be possible for one to choose an intelligent starting point from which to work toward the application of an epoxy system in a particular, perhaps not so typical, end use.

The arrangement of the book is unique in that a conclusion and a bibliography appear at the end of each chapter. A generous amount of graphs and tables are fitted into the easy-to-read text to illustrate the subject matter and to present typical property data. The indexing appears to be sufficiently complete to make the book useful for reference.

For the neophyte, "Epoxy Resins" is recommended reading. The engineer or designer, looking for special properties in a plastic, can form a good idea of the potentialities of epoxy resins.

CORRECTION—The book reviewed last month in these columns under the heading "Solvent Extraction" (p. 319) should have carried the title *Solvent Extraction in Analytical Chemistry.*

BRIEFLY NOTED

FACE-TO-FACE AND END-TO-END DIMENSIONS OF FERROUS VALVES. *22 pp. American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y.* $1.50. Standard covers cast-iron and steel valves having flanges and faces in accordance with American standards, and ferrous butt-welding end valves.

HANDBOOK OF RADIOCHEMICAL ANALYSIS. Vol. 1, Radiochemical Techniques. *152 pp.* $4. Vol. 2, Radiochemical Procedures. *129 pp.* $3.25. *By L. J. Beaufait, Jr. and H. R. Lukens, Jr. Tracerlab,*

Inc. (Western Div.) Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Deals with Radiochemical analysis of fission and nonfission products.

HANDBOOK OF SELECTED BIOLOGICAL REFERENCES ON WATER POLLUTION CONTROL, SEWAGE TREATMENT AND WATER TREATMENT. *95 pp. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.* 45¢. Updates original edition through 1956.

INDUSTRIAL pH HANDBOOK. *80 pp. Compiled by Thomas J. Kehoe. Beckman Instruments, Inc., Process Instruments Div., Fullerton, Calif.* $2. Reviews principles of industrial pH control systems, application and equipment.

1957 NATURAL GAS PIPE LINE MAP OF NORTH AMERICA. *22 in. x 32 in. Gas Age Magazine, 48 W. 38 St., New York 18, N. Y.* $2. Reflects Federal Power Commission's authorization, up to July 1, 1957, of nearly 6,800 mi. of new natural gas pipelines; shows beginning and end of each pipeline, areas to be covered now and later, names of operating companies, in U. S., Canada and Mexico.

MORE NEW BOOKS

CATALYSIS, Vol. 5. Edited by Paul H. Emmett. Reinhold. $15.

SIXTH SYMPOSIUM (International) ON COMBUSTION. The Combustion Institute. Reinhold. $28.

PHYSICAL CHEMISTRY. By E. Moelwyn-Hughes. Pergamon Press. $15.

HANDBOOK OF LAYOUT AND DIMENSIONING FOR PRODUCTION. By H. H. Katz. Macmillan. $15.

CONTROL ENGINEERING MANUAL. By B. K. Ledgerwood. McGraw-Hill. $7.50.

HIGHER OXO ALCOHOLS. By Lewis F. Hatch. Wiley. $4.50.

THERMODYNAMICS FOR CHEMICAL ENGINEERS. By Harold C. Weber and Herman P. Meissner. Wiley. $8.50.

FREE RADICALS IN SOLUTION. By Cheves Walling. Wiley. $14.50.

QUANTITATIVE INORGANIC CHEMISTRY. By G. Charlot and Denise Bezier. Wiley. $15.

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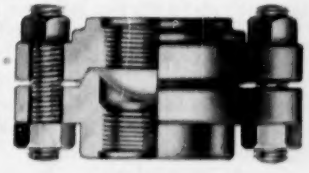

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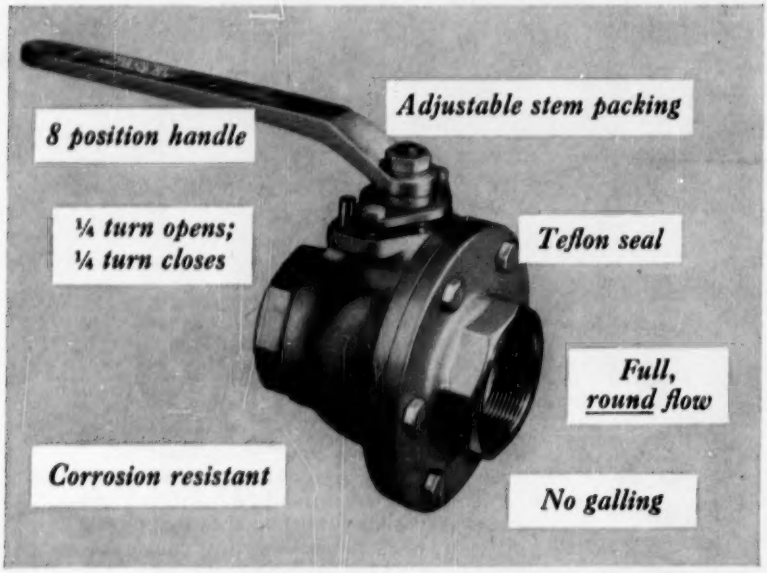
The New Rockwood "316" Stainless Steel Ball Valve
for the chemical industry



Here's why it will fit your needs — Rockwood's new "316" Stainless Steel Ball Valve offers you all the features above — plus easier operation, low pressure sealing and elimination of entrapment of fluid. It's loaded with features and when it's loaded with chemicals it will deliver a full, *round* flow every time! It's available with remote air-operation in wanted sizes ⅜" to 2".

We also have —

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PEOPLE . . .

MEET YOUR

Ronald E. Cannon

HOW TO COPE WITH A WATER SHORTAGE. PAGE 237.

Imagination is one of the outstanding characteristics of Ron Cannon. Because of it, he realized that the subject of this month's report would make an excellent magazine article of much wider than local interest.

It was his initiative, too, that resulted in recording the panel meeting described in our Report. And, it was his labor that boiled down a many-houred session into the 16 pages you now have before you.

Ron is a native-born Texan—born and raised in Beaumont. On graduating from high school, in 1943, he enlisted in the Navy. Three years later, he emerged as a lieutenant (j. g.) after service with the Third Amphibious Unit of the 7th Fleet.

After earning a B. S. in mechanical engineering from Louisiana Poly in 1948, Ron joined Gulf Oil. Initial assignment was with the firm's construction and maintenance departments in Port Arthur, Tex., and Philadelphia, Pa. Later, as field project engineer, he took charge of construction and start-up of major refinery units at the former location—including an ethylene unit.

From January 1956 until mid-August 1957, when Petroleum Processing was discontinued, Ron was Southwestern editor for that magazine. For a brief period, this Fall, Ron repre-

sented Chemical Engineering in the Southwest. Since October 1, he has been associated with the Natural Gasoline Association of America, in Tulsa, Okla.

Benjamin Miller

EQUATION GIVES FRICTION FACTOR. PAGE 253.

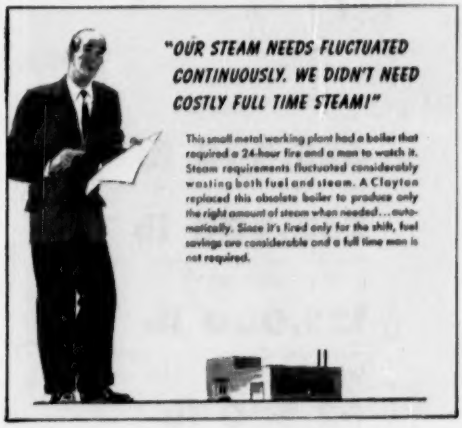
The origin of Benjamin Miller's article probably dates back about ten years. At the time, the American Gas Association and the Bureau of Mines agreed to cooperate on some experimental work and Miller had an opportunity to compare the resulting data with the formula he had already developed.

Actually, though, it wasn't until he saw the results of the ensuing experiments—late in 1956—that he was able to set the tone of the article.

Just how Miller justifies bringing the article to the attention of chemical engineers throughout industry is also worth mentioning. It's his observation that engineers frequently fail to connect their special fields with the special fields of others. Much mutual good results from a better interchange of tools and concepts. That's why he offers a means of handling a high Reynolds number—though, he knows of no other present use than improving confidence in the results of natural gas pipeline design. It's his belief that if he brings his equation to the attention of chemical engineers—engaged in many

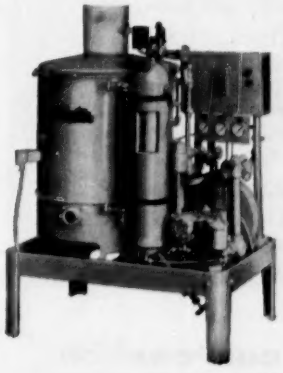
How a Clayton STEAM GENERATOR

"WE WERE FACED WITH AN OBSOLETE CENTRAL BOILER ROOM AND DETERIORATING TRANSMISSION LINES"
This well known chemical company had a sprawling plant with long transmission lines and condensation problems. Fluctuating steam needs throughout the plant made steam production a problem. The ordinary boiler had to be kept at full pressure all day... fired all night. Seven Clayton Generators strategically located now provide just the right amount of steam—when and where needed. They are shut down at night. These seven Clayton generators installed cost less than the cost of new transmission lines.


"OUR STEAM NEEDS FLUCTUATED CONTINUOUSLY. WE DIDN'T NEED COSTLY FULL TIME STEAM!"
This small metal working plant had a boiler that required a 24-hour fire and a man to watch it. Steam requirements fluctuated considerably wasting both fuel and steam. A Clayton replaced this obsolete boiler to produce only the right amount of steam when needed... automatically. Since it's fired only for the shift, fuel savings are considerable and a full time man is not required.

SOLVED THREE *different* STEAM PROBLEMS!

These actual case histories represent only a few of the reasons why smart business men buy Clayton Steam Generators. Basically the story is more steam at less cost in only one fourth the space occupied by ordinary steam boilers. They cost less to install too... no stacks to erect, no walls to knock out, lower rigging expense and lower hauling costs. The secret of Clayton's higher efficiency is *controlled circulation*—no space consuming straight tubes, but instead, a principle of using a coil without fired vessels... easier to operate and maintain. From a cold start, Claytons produce steam in 3 minutes. Let a Clayton representative give you the complete facts.



"IT WAS HOPELESS! WE NEEDED MORE STEAM AND WE DIDN'T HAVE ROOM FOR IT!"
Here was a well known beverage syrup company located in "midtown" squeezed in between buildings on all sides. To meet its additional steam needs, it went in only one direction ...up! Since a Clayton produces the same amount of steam in only one fourth the space and weighs only a fraction as much as an ordinary boiler, it was relatively simple to put two Clayton steam generators on the roof! The installation was quick and inexpensive.

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different types of work—that some one will find some other use for it.

At present, Miller is a consulting engineer associated with H. Zinder & Associates, Inc. He has been engaged in consulting work since 1945. Earlier in his career, he spent a number of years with the Doherty-Cities Service organization.

Miller obtained both his B. S. and M. S. degrees in chemical engineering from Columbia University.

F. X. McGarvey

ION EXCHANGE AS A UNIT OPERATION. PAGE 255.

Since 1945, F. X. McGarvey has been working at the ion exchange application laboratory of Rohm & Haas Co. At the lab, McGarvey is engaged in the development of the engineering aspects of ion exchange resins for water conditioning, uranium processing, and the atomic reactor program.

Just before he joined Rohm & Haas McGarvey spent a year working with the Manhattan District engineers at Oak Ridge and Los Alamos. During most of the war years, however, he worked for the U. S. Navy Dept. on shipbuilding projects with electronic specialization.

McGarvey earned both a B. S. and an M. S. in chemical engineering at the University of Pennsylvania. Since that time, he's also done advance work in chemistry and physics.

This isn't the first time that McGarvey has authored a piece on ion exchange. To date, he has authored or co-authored around 25 article on the uses of this operation in various applications.

Our author's other interests include astrophysics, travel and historial philosophy.

He is a native of Kingston, N. Y.

Max Leva

FLOW THROUGH PACKINGS AND BEDS. PAGE 265.

With this issue, Max Leva concludes his rather comprehensive series of articles on fluid flow through packed beds, which he got underway last January.

Leva, a consulting chemical engineer, has quite an extensive background in liquid-gas contacting and in fluidization. In Pittsburgh, he operates an engineering research laboratory and a consulting practice as well. Development of industrial equipment and processes is his specialty.

His earlier professional life has included periods as a design engineer with such firms as Blaw-Knox and Vulcan Copper & Supply. More recently, he served with the U. S. Bureau of Mines, engaged in research on the technology and engineering problems of the Fischer-Tropsch process and coal gasification.

When he left the Bureau of Mines seven years ago, he went into consulting work for chemical and chemical equipment firms—primarily in the fields of gas absorption, distillation, extraction, fluidization applications, gas making and gas purification.

Leva's undergraduate work at the University of Cincinnati earned him a bachelor's degree in chemical engineering in 1941. Four years later, he took on a master's in the same branch of engineering at Carnegie Insti-

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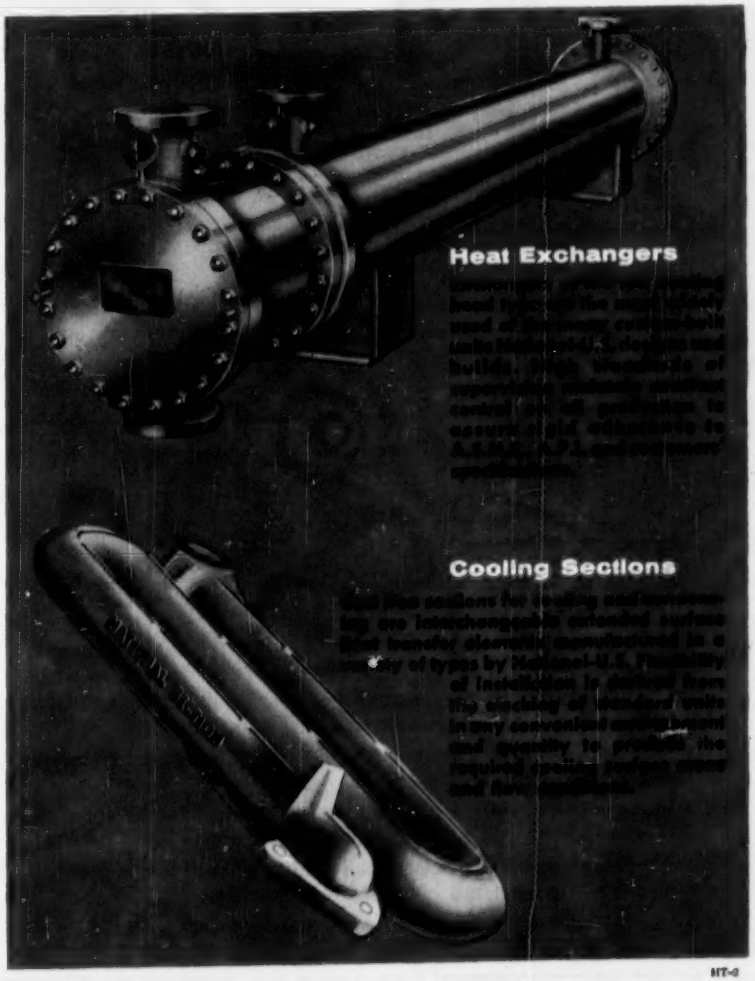

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AUTHORS . . .

tute of Technology. He holds a professional engineering license in Pennsylvania and has authored a number of technical articles—in addition to the current series. Some years ago, he also turned out a book, "Tower Packings and Packed Tower Design," (published by U. S. Stoneware Co.) which is now in its second edition.

Leva is married and has two daughters and a son. Though his periods of relaxation often resemble the traditional busman's holiday—work on new ideas in his laboratory—he does find time now and then, for other hobbies. He likes classical music, gets a kick out of making home movies with his Bolex camera, and enjoys travel.

Albert Boutelle

THAT OVERSEAS JOB: SHOULD YOU TAKE IT? PAGE 313.

If anyone can give you sound advice on choosing an overseas job—and whether you should take it at all—Albert Boutelle is the man to do it. To date, he has spent more than 16 years in overseas posts.

"Hey, wait a minute," you might object, "the man must be prejudiced: After all, he wouldn't have stayed away that long if he didn't like it . . . so what kind of advice can he give?"

No doubt, Author Boutelle did enjoy each of his intriguing posts, but that didn't stop him from keeping a tally of the dimmer as well as the brighter side of overseas life. And, the tight contacts which confine some foreign posts gave him ample opportunity to observe them at close range.

Take a look at the array of overseas posts he's held since 1941, as field engineer for Hamilton Standard (division of United Aircraft). First, after some domestic service, there was India, Ceylon, Burma and Africa. In that job, he served as a military liaison between the U. S. and British Air Forces, for the U. S. War Department. As a result of his work, he earned a commendation for overseas service. All this in the space of one year.

Next, to South America. From 1946 until 1950, he took up residence in Brazil, Argentina, Chile, Uraguay and made periodic visits to other countries too.

In 1951, he joined U. S. Rubber International, in New York—of all places. He wasn't getting "domestic" on us though. Assignments, as an equipment engineer, took him to plants in Canada as well as in the States, handling plant layout and maintenance, purchasing, and materials handling tasks.

Three years ago, he joined Union Carbide International in New York. He spent the first year of that time, in Toronto, as a mechanical engineer at a National Carbon, Ltd., plant. Then, in 1955, Carbide sent him to Monterrey, Mex., as a plant engineer for both National Carbon-Eveready, S. A., and Bakelite de Mexico, S. A.

Two of Boutelle's most pressing interests are the Spanish and Portuguese languages. Good thing, too, what with his assignments. Other interests, including household pets number three dogs and a dozen or so parakeets in addition to their "star boarders," their three children.

At one time, Boutelle reports that he used to have time for hunting, playing the accordion, and some rather serious picture taking. But, these days, his hobbies center around such things as making a survey of the industrial development of South America.

Boutelle earned both his B. S. and M. S. degrees in chemical engineering at Brown University. He was born in Providence, R. I.

In closing, Sahib, we have this to say. If you, too, were born in Providence—or points West—

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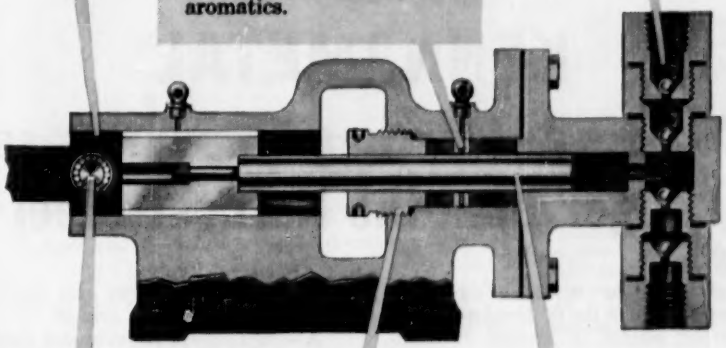

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AUTHORS . . .

and the wanderlust has now gotten the best of you too. . . . See you in Indja!

James W. Bradley

ECONOMICS: PETROCHEMICALS. PAGE 206.

A member of the industrial economics staff of Arthur D. Little, Inc., James W. Bradley gleaned his earliest training at Lafayette College. He earned an A. B. degree from the school in 1951.

Following a stint in the Army, during the Korean conflict, Bradley went on to earn an MBA at Cornell University. When he took leave of the Ithaca campus, he joined A. D. Little in Cambridge, Mass. For the past several years, he has been engaged in economic studies principally in the process industries.

The Bradleys live in Waltham, Mass.

Richard F. Messing

ECONOMICS: PETROCHEMICALS. PAGE 206.

Since he joined Arthur D. Little in 1945, Richard F. Messing has been active working on

technical-economic studies for the process industries. Such studies have included analysis of diversification opportunities, project and market potentials, company acquisitions and related investigations.

At present, Messing is manager of the firm's industrial economic group—of which Co-authors James and Bradley are members.

Messing received his undergraduate training in chemical engineering at the University of Minnesota and then did graduate work at Illinois Institute of Technology. During World War II, he participated in programs of incendiary bomb evaluation for the National Defense Research Committee.

The Messings live in Wellesley Hills, Mass. Though he enjoys golf, Messing reports that his four children compete rather successfully for the lion's share of his spare time.

Robert L. James

ECONOMICS: PETROCHEMICALS. PAGE 206.

Economist Robert L. James of Arthur D. Little, Inc., is also a chemical engineer. He earned his B. S. degree at Oklahoma A & M in 1942. Then, he attended Minnesota Graduate School until 1944.

In industry, James got his start as a research assistant at Allegheny Ballistics Laboratory. There, his experience was primarily in rocket design and testing. In 1945, he joined Publicker Industries as a chemical engineer and process designer. Then, in 1947, he took on a similar post with Cities Service

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Pure Black Iron Oxides	Fe_3O_4-96% min. SpG.-4.96 Color—Blue Black	
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AUTHORS . . .

Research and Development Co. Until 1950, he worked on process design and process studies for the firm.

For the past seven years, James has been associated with ADL's industrial economics group. His assignments have included extensive market studies on synthetic rubber and petrochemicals. His contributions to many ADL reports on these subjects have been substantial.

Professional memberships include Alpha Chi Sigma, Phi Lambda Upsilon, the American Institute of Chemical Engineers and the Chemical Market Research Association.

James lives in Dedham, Mass.

Chin-yung Wen

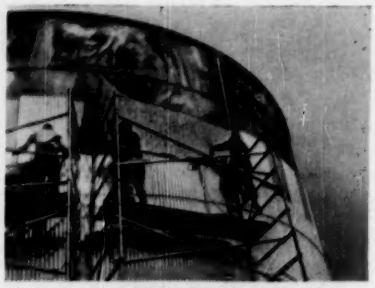
FLOW THROUGH PACKING AND BEDS. PAGE 267.

Up to his elbows in teaching as well as research, Chin-yung Wen is currently assistant professor at West Virginia University.

Besides handling classes in mass transfer, heat transfer and unit operation, Wen has been conducting research in gas absorption, fluidization and solids-gas transport.

Wen earned a B. S. degree from National Taiwan University, Taiwan (Formosa). Later, he received an M. S. in chemical engineering as well as his doctorate from West Virginia University. He also spent a summer working for the research department of Goodyear Tire & Rubber Co.

He belongs to several technical societies and is a member of Sigma Chi and Phi Lambda Upsilon.



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NEWARK, N. J., Eastern Steam Specialty Co.
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NEW ORLEANS, Eagle Asbestos & Packing
NEW YORK, Eastern Steam Specialty Co.
OKLAHOMA CITY, Ball Distributing & Engineering Co.
OMAHA, Cardinal Supply & Mfg. Co.
PHILADELPHIA, John F. Scanlan, Inc.
PITTSBURGH, Dravo Corp.
PHOENIX, Ariz., Kircher Asbestos & Rubber Co.
RALEIGH, N. C., Reynolds Aluminum Supply Co.
RICHMOND, Va., Reynolds Aluminum Supply Co.
ROCKFORD, Ill., Mott Brothers Co.
SALT LAKE CITY, Bullough Asbestos Supply Co
SAN ANTONIO, The Bracken Co.
SAN DIEGO, Western Fibrous Glass Products
SAN FRANCISCO, Western Fibrous Glass Products
SAVANNAH, Ga., Reynolds Aluminum Supply Co.
SEATTLE, Western Fibrous Glass Products
SOUTH BELOIT, Ill., Mott Brothers Co.
ST. LOUIS, The Brauer Supply Co.
ST. PAUL, Asbestos Products Co.
SOMERVILLE, Mass., Thermal Insulation Co.
SYRACUSE, N. Y., Industrial Supply Co.
TAMPA, Fla., Eagle Roofing & Art Metal Works, Inc.
TALLAHASSEE, Fla., Bakers, Inc. of Tallahassee
TULSA, Okla., Ball Distributing & Engr. Co.
TUPELO, Miss., Paine Supply Co.
WASHINGTON, Walter E. Campbell Co., Inc.
WICHITA, General Metals, Inc.
VANCOUVER, B. C., Fleck Brothers Limited

GUSTIN gb BACON

A "deluxe job"—at low cost—with ULTRALITE insulation

Before Ultralite, insulating a tank meant laborious laying up of block after block or batts and more batts all wired together or banded in place with a resulting high insulation cost and many more joints to leak heat. Weatherproofing the completed job with metal made it prohibitively high. But now, Ultralite lowers the cost of insulating so substantially that insulation *plus* metal weatherproofing is a low cost operation; you can have a "deluxe job"—maintenance free, at reasonable cost.

Ultralite saves material handling costs and speeds up application in many ways.

1. Large sections of tank can be insulated at one time with wide continuous blankets of Ultralite, the long glass fiber insulation. In fact Ultralite can be furnished in blanket rolls up to 10 ft. wide and single thicknesses of 6".

2. Ultralite cannot be damaged due to rough handling — will not lose thickness, break or shrink because it is tough and resilient.

3. Fewer fastening members are required because Ultralite is light weight.

4. Ultralite is shipped to the job in compressed rolls — takes up less space.

And, as a "bonus" feature Ultralite offers greater heat savings because of its low K and less joints.

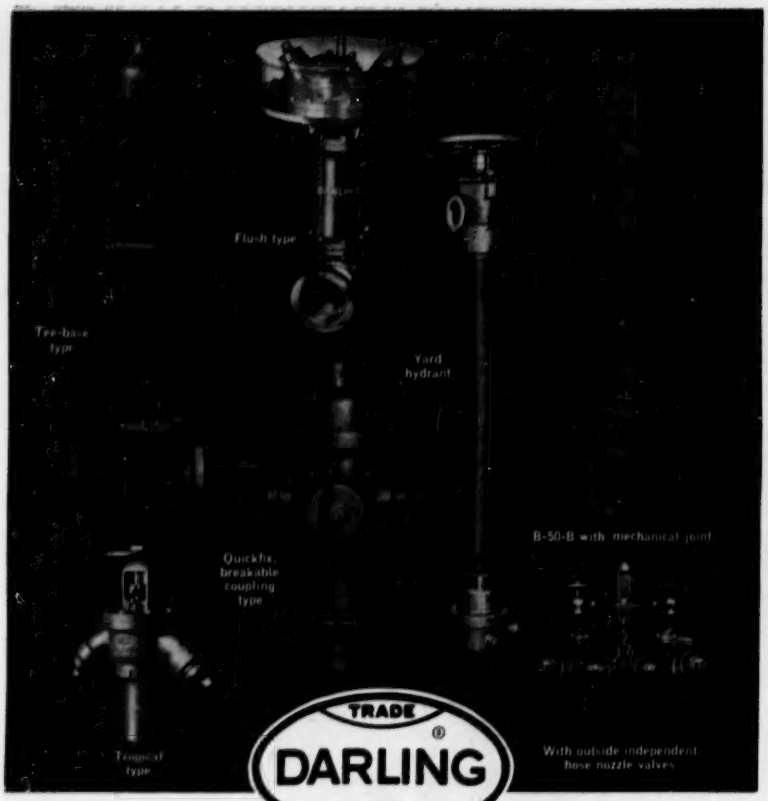
If you are now specifying blocks or batt insulation for heated equipment with troweled finishes or sprayed-on weatherproofing, it will pay you to investigate the advantages of an Ultralite-insulated job—completely and permanently weatherproofed with metal. Write to G-B for detailed specifications.

CALL YOUR LOCAL G-B DISTRIBUTOR LISTED IN ADJOINING COLUMN

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation

252 W. 10th St., Kansas City, Mo.



HYDRANTS

- Best for plant fire protection
- Types and sizes for all requirements

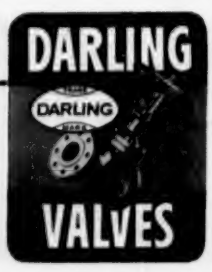
Two reasons why Darling fire hydrants can give your facilities the protection you need . . . instantly . . . *when you need it!*

***First,* you can locate Darlings to greatest possible advantage because there are sizes and types for every conceivable installation requirement and condition.**

***Second,* these modern hydrants are unmatched for advanced operating features. The Darling B-50-B development means ball bearing operation combined with "O" ring seals. Result: packless, dry-top hydrants. Operating threads *stay* lubricated and water can't reach them! Operation is far easier, faster, surer . . . and maintenance is avoided.**

Send for Bulletin 5710. Better still, let us send an engineer to analyze your requirements and make specific recommendations.

DARLING VALVE & MANUFACTURING CO.
Williamsport 3, Pa.
Manufactured in Canada by
The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ont.



PEOPLE . . .

LETTERS:

Elephants Foot, Not Sisal

Sir:

In your July 1957 issue (p. 170) there is a photograph which was taken in the early days of Boots corticosteroid manufacturing. The caption states that Boots' synthesis is from hecogenin obtained from sisal.

This is completely incorrect. We have never made cortisone from sisal. We use as a starting material a plant found in South Africa called *Testudinaria sylvatica.* Because of the unique shape and scaly surface of the rhizome of this plant, it has been given the name "elephants foot." From elephants foot, we manufacture diosgenin, from which corticosteroids are synthesized.

G. L. FOULKES
Boots Pure Drug Co. Ltd.
Nottingham, England

Much Ado About Zero

Sir:

I always read *Chemical Engineering* carefully to absorb as much as possible of the brilliant scientific matter carefully placed therein. Occasionally it gets over my head, as I am far beyond the period when one can reasonably expect to earn a living on matters he thought he knew many decades ago.

This has recently happened to me. I am very much interested in nitric acid plant design, so I studied carefully a story on a new nitric acid plant in your

PRO & CON

C. H. CHILTON

September issue (p. 144), designed by Chemical & Industrial Corp. These plants up to now have been only reproductions of the 1940 Du Pont plant, with a turbocompressor and expander substituted for the reciprocating compressors used by Du Pont. Aside from this, no development has been done on this old process for 17 years.

The article is very brief—perhaps one reason I am so dumb about grasping what the heart of the story is. It appears to state that the new plant will run without the necessity for supplying any additional power to the nitric acid plant as such, by using the waste-heat steam.

This, of course, has been done for many years if anyone wanted such a plant. However, when it is done only at the expense of using the waste-heat steam, and supplying an extra, expensive steam turbine, there are few places where the net power saved, after charging in a lot of good steam, would be attractive. Chemical Construction Corp. makes acid in any size plant at a very low power cost (4-5 kwh./ton), without touching the by-product steam; it is all available for other uses. If required to do so they will furnish a plant using no power at all.

As I read the story, however, the above is of little importance. The real geld is in making 250 tons/day of acid with so little air it requires only 600 hp. to compress it to 120 psig. Or perhaps I should say C&I has learned to compress 23,730 scfm. of air to 120 psig. with only 600 hp. To my mind, this is the real trick, either way they do it.

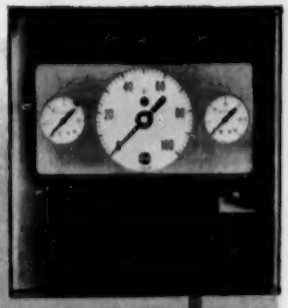
CHARLES OWEN BROWN
Consultant
New York, N. Y.

► *We take full responsibility for inadvertently dropping a zero; compressor horsepower will be 6,000, not 600 as we reported. For further comment, see next letter.*—ED.

Sir:

I believe that Dr. Brown has missed the point that this is a high-pressure plant and, there-

From TRANSMITTER to RECEIVER GAUGE



unequalled USG® sensitivity-dependability

There's never a question as to the accuracy of temperature or pressure readings when transmitted by USG Pneumatic Transmitters.

And for accurate reception of signals from remote points, there's nothing to match the sensitivity of the new USG Receiver Gauge.

Consider these features:

USG PNEUMATIC TRANSMITTERS

- Sensitivity—Within 0.1% of full scale.
- Accuracy—1% (indicating) or ½% (non-indicating)
- Designed to operate at remote points for long periods without attention. High sensitivity, linearity and freedom from dead spot assure the ultimate in control stability.

USG PNEUMATIC RECEIVER GAUGES

- Sensitivity—Within 1/10 of 1% of full scale.
- Accuracy—± ¼ of 1% of full scale.
- Diaphragms made of Ni-Span "C", a special high nickel alloy with a minimum thermal shift, even under wide variations in ambient temperature.
- Available in 3½", 4½", 6" and 8½" sizes.
- Also available are 2", 2½" and 3½" Bourdon tube actuated type receiver gauges.

USG Transmitters and Receiver Gauges are part of USG's line of creatively engineered process control instruments. The line includes gauges, pressure and temperature pilots, recorders and controllers. Write for catalogs.

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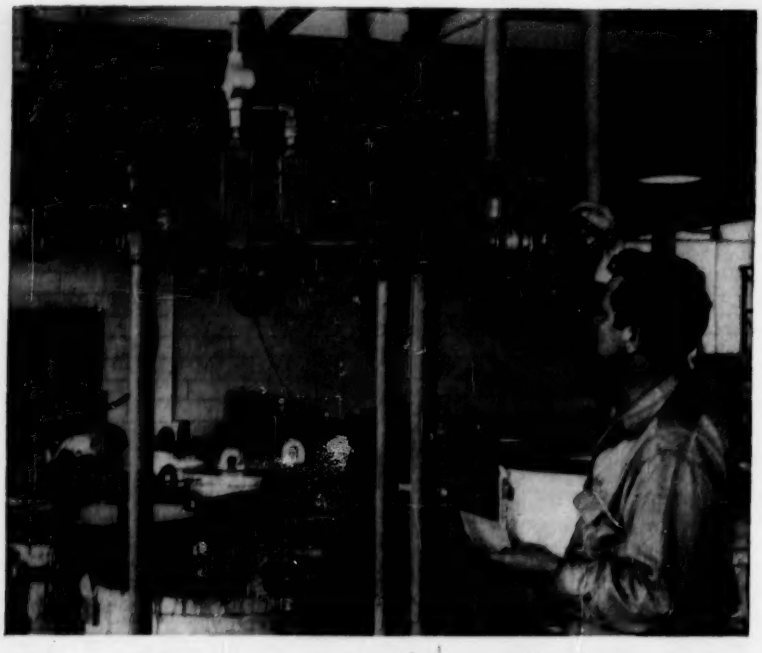


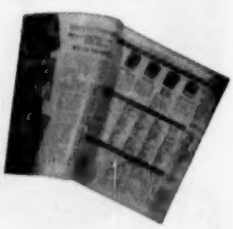
How **NEPTUNE** *liquid* **METERS**

help keep Glidden paint smooth-flowing

Paint covers best . . . and makes repeat sales . . . when it *always* has a smooth, creamy consistency—not drooling all over . . . nor too stiff to spread out. That's where Neptune meters help Glidden. Each batch gets precisely the amount of liquids specified by the formula for best paint performance.

Neptune meters boost Glidden production, too, over slow manual batching. Operator simply presses the buttons to set the amount required . . . opens the valve . . . and meter shuts off at the right amount. Improved plant housekeeping and operator morale are other benefits of measuring liquids the modern way . . . *in the pipe.*

Neptune meters handle over 150 liquids—hot and cold water, syrups, liquid sugars, oils, brines, soap solutions, and many chemicals. Sizes range from ⅜ to 6 in. . . . Capacities from 2 to 1000 gpm.



Ask for Meter Data Book 566-D

neptune liquid METERS

NEPTUNE METER COMPANY

19 West 50th Street, New York 20, N. Y.

Branches in: ATLANTA • BOSTON • CHICAGO • DALLAS • DENVER • LOS ANGELES • LOUISVILLE • No. KANSAS CITY, Mo. • PHILADELPHIA • PORTLAND, ORE. • SAN FRANCISCO, (Millbrae) • IN CANADA: TORONTO 14, ONT.

fore, obviously superior to low-pressure ones. It is the first high-pressure plant with which we are acquainted that compresses its air without outside power.

As to the misprint which reads "600 hp.," I noticed it too, but passed it up since I realized that the weakness of all engineers (not excluding Ch.E.'s) is the loss of the decimal point!

D. M. CARR
Chemical & Industrial Corp.
Cincinnati, Ohio

Pro: Commercial Zirconium

Sir:

In your September issue, in an article on atomic-age metals (pp. 208-210), you make the statement that one new zirconium producer, U. S. Industrial Chemicals, is preparing to promote the metal for commercial (non-nuclear) uses.

I would like to call your attention to the fact that we have run advertisements in your magazine for June, July and August, as well as in a number of other magazines, which were directed specifically at commercial-grade zirconium. Carborundum Metals Co. ran a similar type of ad in, at least, your August issue. In addition, we and Carborundum have been distributing samples and actively promoting uses.

We are, of course, appreciative of any publicity on the subject of zirconium and do not mean to be unduly critical, but it does seem rather strange that a more thorough check was not made when there are only four producers and each can be

reached quite easily by telephone.

J. W. BLANTON
Columbia-National Corp.
Cambridge, Mass.

► *As a matter of record, we did check all four producers by telephone in order to report accurately and clearly the important but heretofore confused picture on plant capacities.*—ED.

Con: Job-Changing Costs

Sir:

Please tell job-changers Bill and Jean Brown (Aug. 1957, pp. 313-316) to stop crying!

There is not one item in their long list of sad tales that they could not have investigated before deciding to make their move. In fact, not having checked the points in question seems to me to make their move an act of rashness and mutual irresponsibility.

Wake up, Bill, or both you and your employer will be disappointed in each other very quickly—and you can start crying all over again.

(This opinion is my own, not my employer's.)

B. K. SANDERS
National Research Corp.
Cambridge, Mass.

Pro: Fun on the Road

Sir:

Mr. Battista's article, "How to Enjoy Work While on the Road" (Sept. 1957, pp. 321-328), is unquestionably the best I have seen on this subject and brings out many points of value to any man who travels.

I am planning to distribute it to all our field men, as well as salesmen.

R. W. REEDY
Kennedy Van Saun Mfg. & Eng. Corp.
Danville, Pa.

Sir:

So far as Mr. Battista's suggestions on expense accounts are concerned, I have been doing exactly what he recommends for almost ten years, and so have other travelers I know.

However, I am sure that Mr. Battista is careful, as I am, to make sure that all expenses itemized on the written report

You CAN take it with you!

A Portable VACUUM UNIT BY GRAHAM

A complete package unit on wheels that can be moved from one job to another.

These Graham PORTOVAC assemblies are economical and efficient—zero maintenance—and low in initial cost.

Wherever you have steam we can give you vacuum.

Write for details in Bulletin 70-A

GRAHAM MANUFACTURING CO., INC.
415 LEXINGTON AVENUE, NEW YORK 17, N. Y.
Offices in principal cities and Canada

DRY AIR . . .
PRECISELY as you want it

- to control your product's quality
- to prevent condensation on your product or material
- to prevent changes due to moist air in contact with your product
- to protect your material from dampness
- to protect your processing of moisture-sensitive material
- to DRY your material or product
- to pack or store your product safe from moisture damage
- to get exact moisture control for the precise atmosphere condition you need
- to provide precise atmospheric conditions for testing
- to increase your air conditioning capacity
- to DRY large quantities of fresh air from outdoors

The Niagara's Controlled Humidity Method using HYGROL moisture-absorbent liquid is

Best and most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result constantly and always.

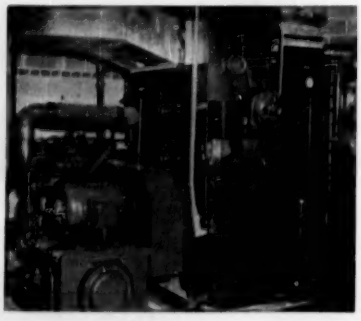
Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

Most flexible because . . . you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Easiest to take care of because . . . the apparatus is simple, parts are accessible, controls are trustworthy.

The cleanest because . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.

This method removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the leaving air. Heating or cooling is done as a separate function.



AT THE
CHEMICAL SHOW
26th EXPOSITION OF CHEMICAL INDUSTRIES
Coliseum, New York City, December 2 – 6, 1957
See NIAGARA
AIR CONDITIONERS • Aero HEAT EXCHANGERS
Aero AFTER COOLERS • Aero REFRIGERANT CONDENSERS • Aero STEAM CONDENSERS
Aero VAPOR CONDENSERS • HUMIDIFIERS
HEATERS • COOLERS • DRYERS
BOOTH No. 655

Write for full information; ask for Bulletins 112 and 121 Address Dept. CE-12

NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada

are tax-deductible. Many companies provide expense-account forms on which there is simply no place to record expense items which are not tax-deductible.

Mr. Battista's friend, Donald J., is fortunate indeed that he can find the time on his trips to do work he has brought along from the office. I am rarely able to satisfactorily complete even the reports of calls made on the trip prior to returning to the office. (Notes on calls, however, are mandatory.)

In general, I find very little in this article with which I do not agree.

T. M. JACKSON, JR.
Johns-Manville Products Corp.
New York, N. Y.

Pro: Indexing System

Sir:

I have a suggestion to offer which I believe would be a significant service on your part, should you adopt the idea.

There are undoubtedly many subscribers like myself who do not have facilities for saving every issue. We must be content to clip for our personal files only those features and articles which interest us.

At one time I attempted an ambitious program for filing my assorted literature under a decimal classification system, using as a guide an article by W. L. Bolles in *Petroleum Refiner* (May 1949). However, a filing technique of this type proved to be too time-consuming, and I abandoned it in favor of a system using loose titles, such as "Heat Transfer," "Fluid Flow," etc.

While Mr. Bolles's system is an excellent piece of work, I abandoned it because it lacks that which every library using a decimal system has—an alphabetical index of the subject headings listed in the decimal classification system.

My suggestion is this: You should compile a comprehensive decimal classification system for chemical engineering knowledge and publish it as an article. Then, using this system, you would identify every article and feature in your magazine with its file number, placed conspicuously in the upper right-hand

corner of the page. Thus your subscribers would have an accurate technical filing system of articles clipped and collected from *Chemical Engineering.*

I'm sure you will agree that the engineer will accumulate a staggering volume of technical literature as he gets deeper into his profession. Any system or aid which will help him maintain a useful reference file would be greatly appreciated.

I. H. WEISSMAN
Shell Oil Co.
Houston, Tex.

▶ *How many of our readers agree with Mr. Weissman that a decimal classification system for chemical engineering knowledge would be useful? We would like to get your opinion before undertaking such a project. Just address an informal letter to Editor, Chemical Engineering, 330 W. 42nd St., New York 36, N. Y.*—ED.

Advertising Age, September 30, 1957

Chicago
Chicago, egan an Beatrice R. Dean ger han- egion for Finegan director aha. Mr. h Benton Craig & as named ith Hen- its crea-

ESCAPE FROM TENSION

Englander introduces
THE MATTRESS DESIGNED TO HELP YOU

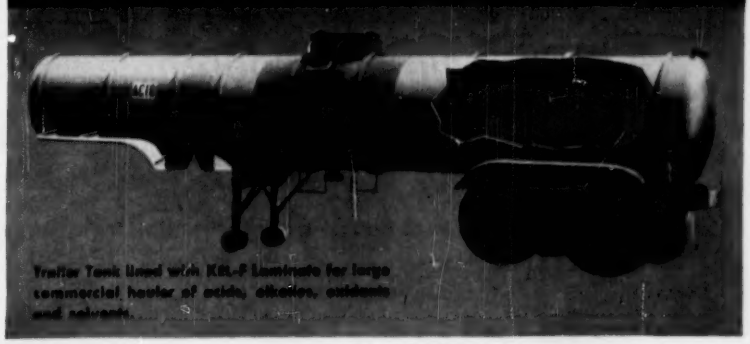
It's Not Heat, It's Tension

INTER-OFFICE MEMORANDUM
To: Hugh Sharp, Promotion Mgr.
From: C. M. Crowe, Atlantic District Sales

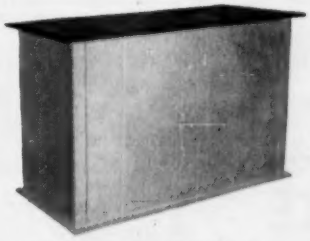
This mattress ad looks like CE's now-famous "high-temperature" cover (Mar. 1957). It's a shame that we don't have a copyright or patent for this type of lettering.

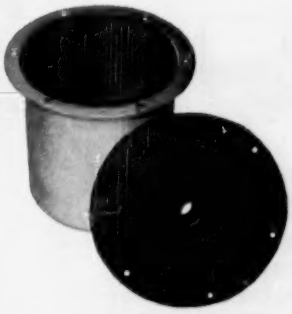
▶ *It may be uranium's ability to generate heat—or its corresponding ability to generate tension—that influenced the style of a recent ad for Wilfley pumps.*—ED.

add complete
CORROSION RESISTANCE


Trailer Tank lined with KEL-F Laminate for large commercial hauler of acids, alkalies, oxidants and solvents.

...with KEL-F LAMINATE lining


100 gal. Tank lined with KEL-F Laminate handles acid fluorides.


Reactor-pot, cover and nozzles lined with KEL-F Laminate.

Make ordinary equipment—tanks, vessels, pipe, chutes, ducts, hoppers, vats, drums—resistant to gases and liquids as corrosive as fuming nitric acid—with KEL-F Laminate.

TOUGH—SHATTERPROOF—KEL-F* Laminate is a durable, abrasion resistant, chemically inert fluorocarbon plastic, bonded to a glass-cloth backing for maximum adhesion. It is readily cemented to any material of construction—metal, wood, concrete, etc.—and over a variety of contours.

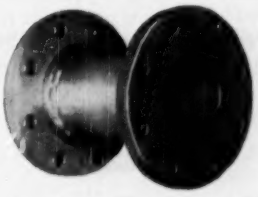
HEAT-SEALED SEAMS—KEL-F being a thermoplastic resin, seams may be "welded", on the job by the thermal pulse technique, into a continuous lining having zero water absorption and extremely resistant to acids, alkalies, oxidants and solvents at temperatures up 350°F.

CERTIFIED APPLICATORS—KEL-F Laminates are manufactured by the United States Gasket Company, pioneers and leaders in fluorocarbon plastics, and are available for installation by certified applicators. Write for further information and the name of applicator nearest you.

UNITED STATES GASKET COMPANY
Camden 1, New Jersey

*Trademark, Minnesota Mining & Mfg. Co.

4-inch pipe coupling lined with KEL-F Laminate for sulfuric acid service.



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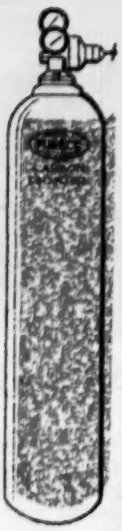
OF THE GARLOCK PACKING COMPANY

PURECO CO_2

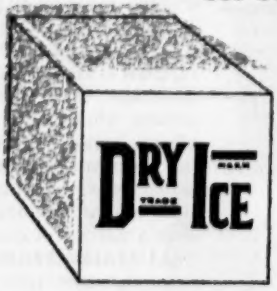
The answer to your problem?



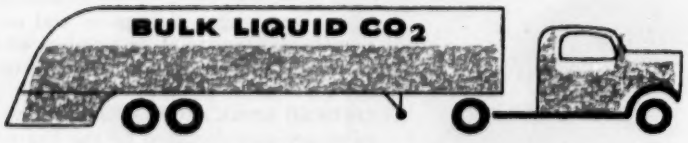
Investigate CO_2 as an Inert Gas for

- pharmaceuticals
- paints and dyes
- packaging
- purging and blanketing
- inert pressure transfer
- explosives
- powdering

Use CO_2 as a Refrigerant for



- pharmaceuticals
- grinding, plastics, resins, gums, etc.
- rubber tumbling
- vacuum traps
- low temperature testing
- lyophilizing



Specify CO_2 as an Ingredient in

- pharmaceuticals
- ph control
- foam rubber
- asbestos cement cure
- carbonation
- foam plastic
- water treatment
- manufacture of carbonates

Pureco CO_2 is quickly available—in solid "DRY ICE", liquid or gaseous form from over 100 sales and service depots. There are also a variety of Pureco CO_2 supply systems available—cylinders—cylinder banks, converters, receivers—each "tailored" to fit your particular requirements.

Pureco Technical Sales Service is qualified through its research in the field to assist you in adapting CO_2 to your particular process. Call Pureco today.

PURECO CO

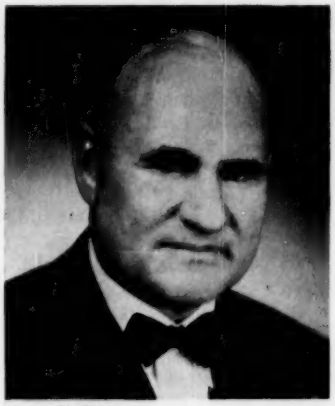
Pure Carbonic Company

A Division of Air Reduction Company, Incorporated
150 EAST 42nd STREET, NEW YORK 17, N. Y.

AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT

PEOPLE . . .

NAMES IN



Zay Jeffries

Men of

Former vice president and general manager of GE's chemical and metallurgical dept. speaks at Award Dinner.

The gentleman slated to give the keynote address at *Chemical Engineering's* Achievement Award Dinner, Tuesday, December 3, is Zay Jeffries—former vice president and general manager of General Electric's chemical department.

A metallurgical engineer, himself, Dr. Jeffries will speak on "Chemical Engineering and Extractive Metallurgy—A Fruitful Partnership."

During World War II, Jeffries was a consultant to Dr. A. H. Compton of the University of Chicago's metallurgical laboratory. Work, of course, was on the development of the atomic bomb.

Dr. Jeffries has to his credit a large number of publications as well as many achievement awards. In the past, he has been chairman of Institute of Metals division, American Institute of Mining & Metallurgical Engineers, chairman of the board of trustees, Battelle Memorial Institute and chairman of the division of engineering, National Academy of Sciences.

THE NEWS

M. A. GIBBONS

Joseph A. Neubauer

the Month

Chemical engineer — specialist in chlorine technology — is now president of Columbia-Southern Chemical.

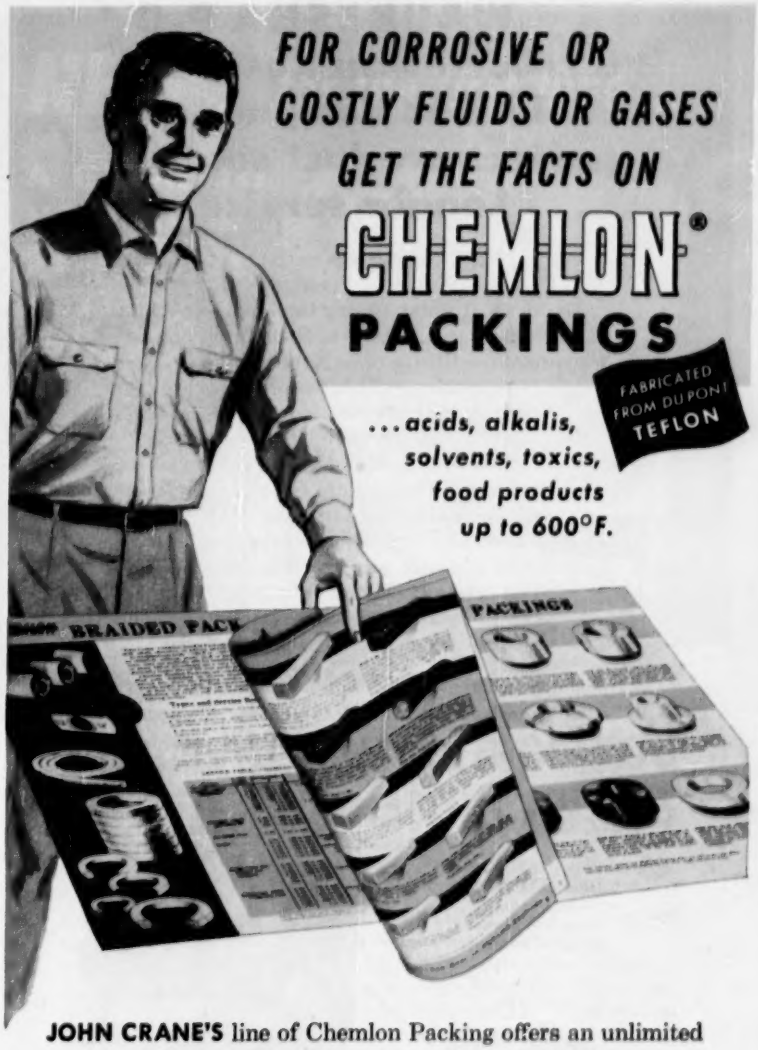
In the months before 20-year old Joseph A. Neubauer received his B. S. in chemical engineering from Case Institute of Technology, he was not wined and dined by an assortment of recruiters. The year unfortunately was 1932.

He had no job.

Neubauer, who at 46 was recently elected president of big and rapidly expanding Columbia-Southern Chemical Corp., recalls that he didn't land that first job until three months after graduation. And, when he started in, he found himself working as a punch press operator in a machine shop.

▶ **The Right Road**—Six months later and with the aid of Dr. W. R. Veazey, then dean of chemical engineering at Case, the young chemical engineer began his first job in the chemical industry. This was with a bankrupt chemical organization which new management was attempting to rejuvenate.

Neubauer says he started off with an impressive title—night superintendent. The hours were



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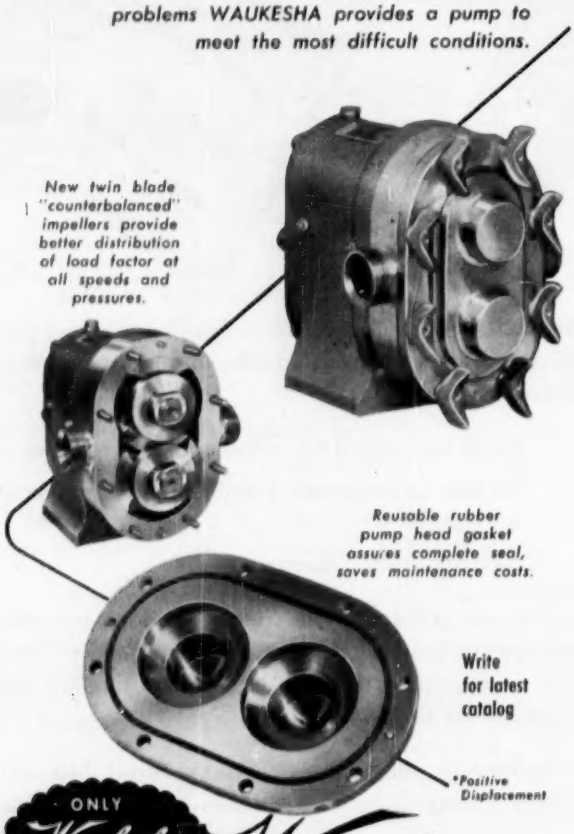

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from 6 p.m. to 6 a.m., seven days a week. The job had one big advantage the Columbia-Southern president now admits, "It was one way to get a lot of experience in a hurry."

Within six months, he moved to another small chemical operation in his native Cleveland. Work schedule dropped off to a leisurely—by comparison—5½ day week. He found that he was the only graduate chemical engineer on the job. Initial assignment was to start up an ammonia nitrate plant. He credits access to a Cleveland public library and plenty of night work with technical books for helping him successfully start up the ammonia nitrate plant on schedule.

▶ **The Real Start**—Dean Veazey again entered the picture and introduced him to Columbia-Southern (then known as the Columbia Chemical Division of Pittsburgh Plate Glass Company). Hired as a trainee and scheduled to be a shift foreman at the Corpus Christi, Tex., plant then under construction, the young chemical engineer was assigned instead to the soda ash process department at the Barberton, Ohio, plant.

After six months at Barberton, six hours a day, on a seven day week, Neubauer recalls that he figured Columbia had forgotten that he existed. During the next year, however, he worked every hourly job in the process department in the big Barberton facility.

The big break for Columbia-Southern's future president came in 1936 when the company decided to enter the chlorine field. He was one of several chemical engineers selected to go to Westvaco's Charleston, W. Va., plant for four months to study the chlorine field—soon to form a large core of the firm's business. Neubauer started up the company's first chlorine unit and was appointed chlorine department superintendent.

Looking back on Columbia-Southern's introduction to chlorine production, Joe admits that he and his colleagues "ate an awful lot of chlorine" before they got it under control.

▶ **Nearing the Summit**—Just before Pearl Harbor, the company

had decided to pioneer with a chlorine-caustic plant in the Ohio Valley, below Wheeling. Chief process engineer, of course, was the company's chlorine expert, Joe Neubauer. And, when the plant was completed and placed in operation, he stayed on as works manager.

Following World War II, Neubauer—as an expert for the U. S. Department of Commerce—investigated all chlorine and soda ash plants in Germany and Austria. "Germany," he says, "was really on its heels when I got back there a few weeks after the war. But, now, what a difference. That country has made a fantastic recovery."

In 1946, he was named technical advisor to E. T. Asplundh, then president of Columbia-Southern and now board chairman of Pittsburgh Plate Glass Company. The following year, he spent the bulk of his time on the design of a large chlorine-caustic plant at Lake Charles, La.

He returned to Germany and Austria in 1947, for the Department of Commerce, to investigate the hydrogen peroxide industry. Two years later, he became technical director for Columbia-Southern—which included supervision of the research and development departments. Then, in 1955, he was elected to the board of directors and to the position of vice president and technical director.

► **Early Interests**—Youngest of six children of Ferdinand and the late Mary Neubauer, Joe was the only member of his family to get a college education. He graduated from Lincoln High School in Cleveland where he excelled in the science subjects.

Vocational guidance didn't amount to much then. Neubauer recalls that when he was ready to enter Case Institute he had little notion of the difference between a chemist and chemical engineer and meager means of finding out.

Throughout his high school and college education he helped pay his way by working after classes. Jobs ran a colorful gamut from punch press operator, caddy, cook's helper in a food processing plant, to laborer on a truck farm. But, while at Case, he still found time to come

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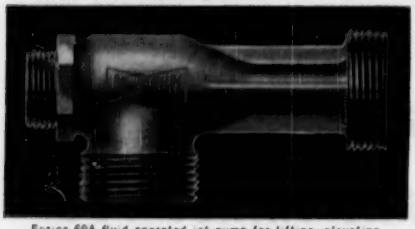
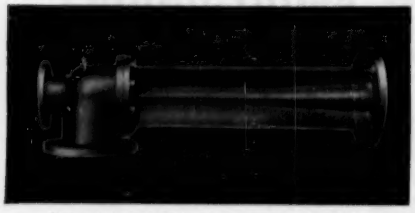


Series 60A fluid operated jet pump for lifting, elevating and blending liquids or slurries.



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▶ **At Home**—The Neubauers, including wife Marian, Josette 16, Nancy 12, and Jeffery 8, live in Mt. Lebanon, Pa., a Pittsburgh suburb. Josette, Joe reports, is showing talent in science and math and may someday become a secondary school math teacher.

Robert C. Swain

Richard S. Perkin, president and chairman of the board of Perkin-Elmer Corp., has announced the election of Robert C. Swain as a director of the Norwalk, Conn., firm.

Swain is also vice president and director of American Cyanamid Co. He joined Cyanamid as early as 1934 and took on the post of director of research in 1945. The following year, he became vice president in charge of research and development and a Cyanamid director.

More recently, he accepted further responsibilities as director of Jefferson Chemical and of Stanford Research Institute.

A native of Palo Alto, Calif., he is a graduate of Stanford University, located in his home town. Swain then continued his studies at the Universities of Heidelberg and Berlin.

Arthur J. Witten has been appointed assistant project engineer of weapon system support equipment for Aerophysics Development Corp., Santa Barbara, Calif.

Paul D. May has been promoted to senior chemist in the research and development department of American Oil Co.

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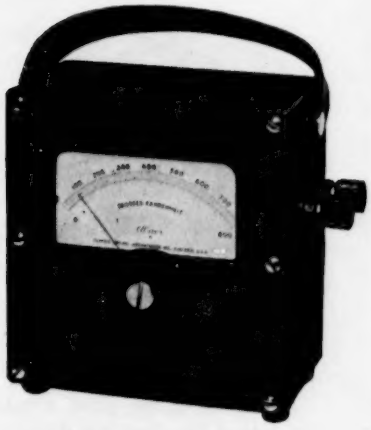

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NAMES . . .

May is a graduate of the University of Frankfurt and of the Sorbonne.

John J. Flaherty, formerly manager of the AEC's Chicago operations office, has been named assistant to the general manager of Atomics International, Canoga Park, Calif.

Howard A. Brandeland has joined the Armour Laboratories engineering department in Kankakee, Ill.

Philip G. Connell Jr. has been named to the post of assistant general manager, pigments division, American Cyanamid Co., New York, N. Y.

Maurice G. Taylor

The Niagara chapter of the American Institute of Chemists named Maurice G. Taylor to receive an honor scroll, in recognition of his significant contributions to the Niagara frontier chemical industry and service to the organization.

Taylor, third recipient to receive the award in the chapter's 25-year history, is owner and director of Taylor Research Laboratories. He helped organize the Niagara chapter, became a charter member of it and, at one time, held the post of chairman.

A native of Howe, Ind., Taylor is a graduate of Purdue University. During World War I, he served in the Chemical Warfare Service at Edgewood Arsenal. Then, he joined Mathieson Chemical in Niagara Falls, N. Y., where he held a variety of chemical posts until he took on his ultimate duties with the firm as

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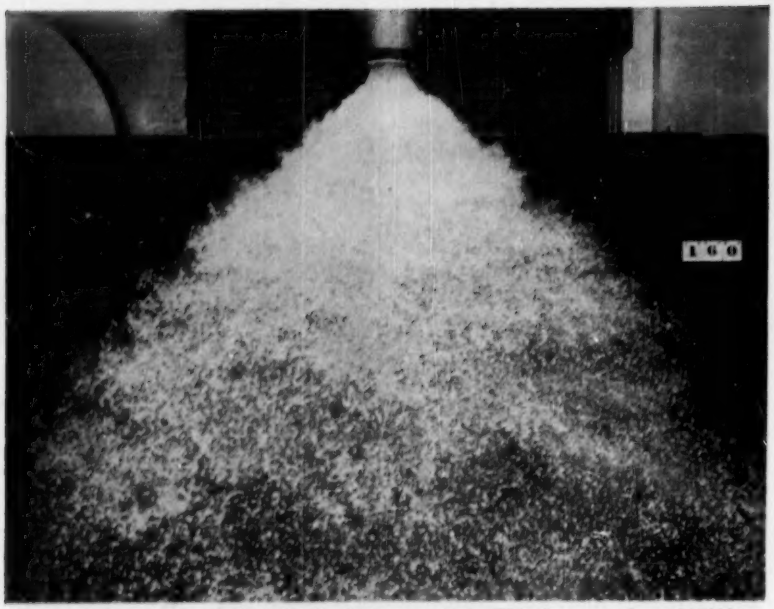

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resident director of research and development.

Taylor's hobbies include figure skating and music. Both Mr. and Mrs. Taylor are accomplished musicians and have promoted the development of the Niagara Falls Philharmonic Orchestra since it was organized.

Herbert R. Erickson

A veteran in the plastics field has joined the chemical division of the Borden Co. as development manager of its Resinite department. He is Herbert R. Erickson, formerly with Boeing Air plane Co.

Erickson will be headquartered at the firm's Santa Barbara, Calif., operation.

In his post at Boeing, Erickson developed and coordinated specifications in the fields of plastics, adhesives and sealants. Before joining Boeing, he had been associated with The Tower Co., Seattle, Wash., which he served as director of the plastics division and later as general manager.

A graduate of the University of Colorado, Erickson holds a B. S. in chemical engineering and a master's in chemistry.

Edward D. Shanken has been named executive secretary of the American Association of Cost Engineers.

Frederick W. Fink has been named chief of the corrosion research division at Battelle Memorial Institute, Columbus, Ohio.

Herbert I. Chambers has been appointed chief development

engineer, Consolidated Electrodynamics Corp., Pasadena, Calif.

E. S. Pasternack of the research council of Alberta, Edmonton, has succeeded **W. A. Flook** of Canadian Chemical Co., as chairman of the Edmonton section of the Chemical Institute of Canada.

William J. Roberts has been appointed director of research of the Summit, N. J., research laboratories of Celanese Corp. of America.

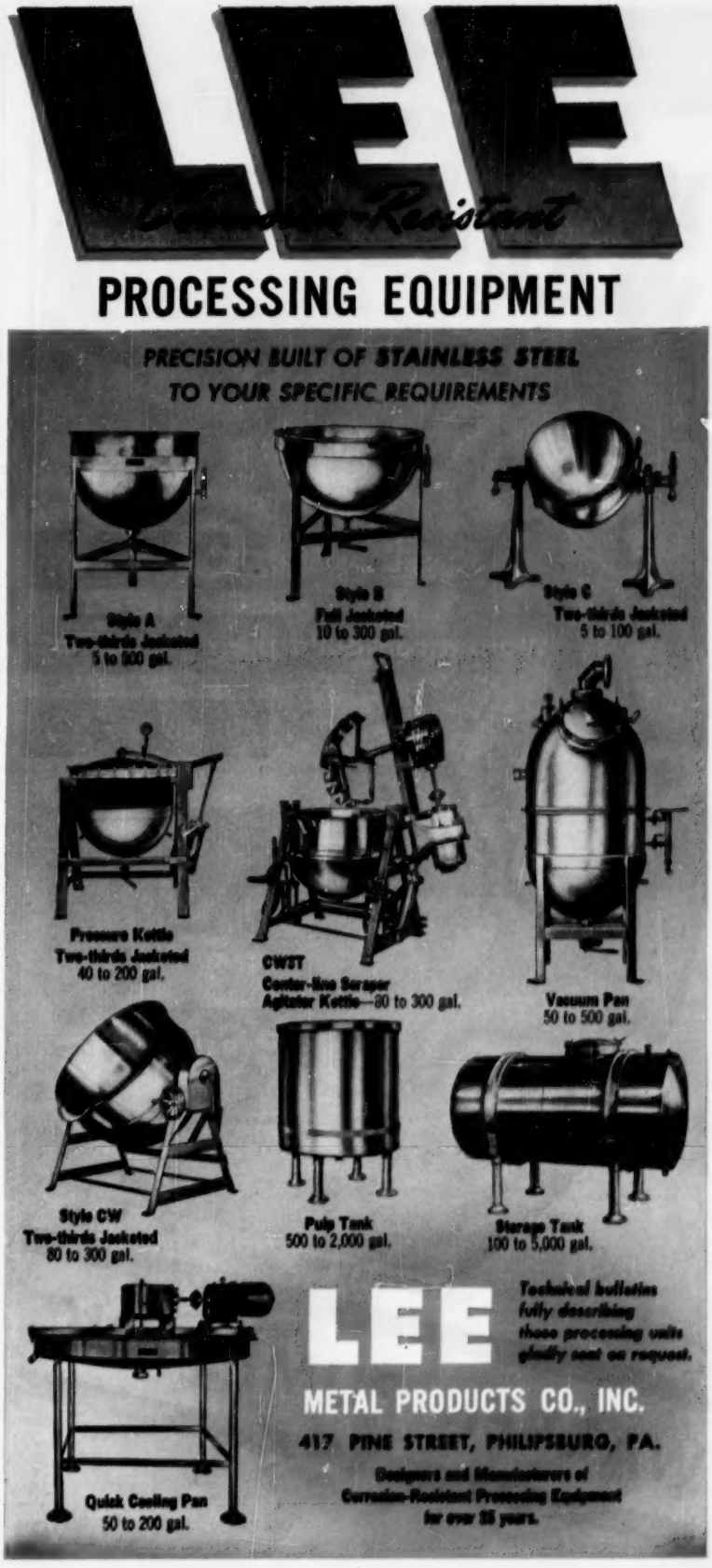
Louis L. Carpenter has been appointed assistant director of the process division in Bakelite Co.'s development laboratories in Bound Brook, N. J. At the same location, **George H. Morton** is now a group leader in the packaging division.

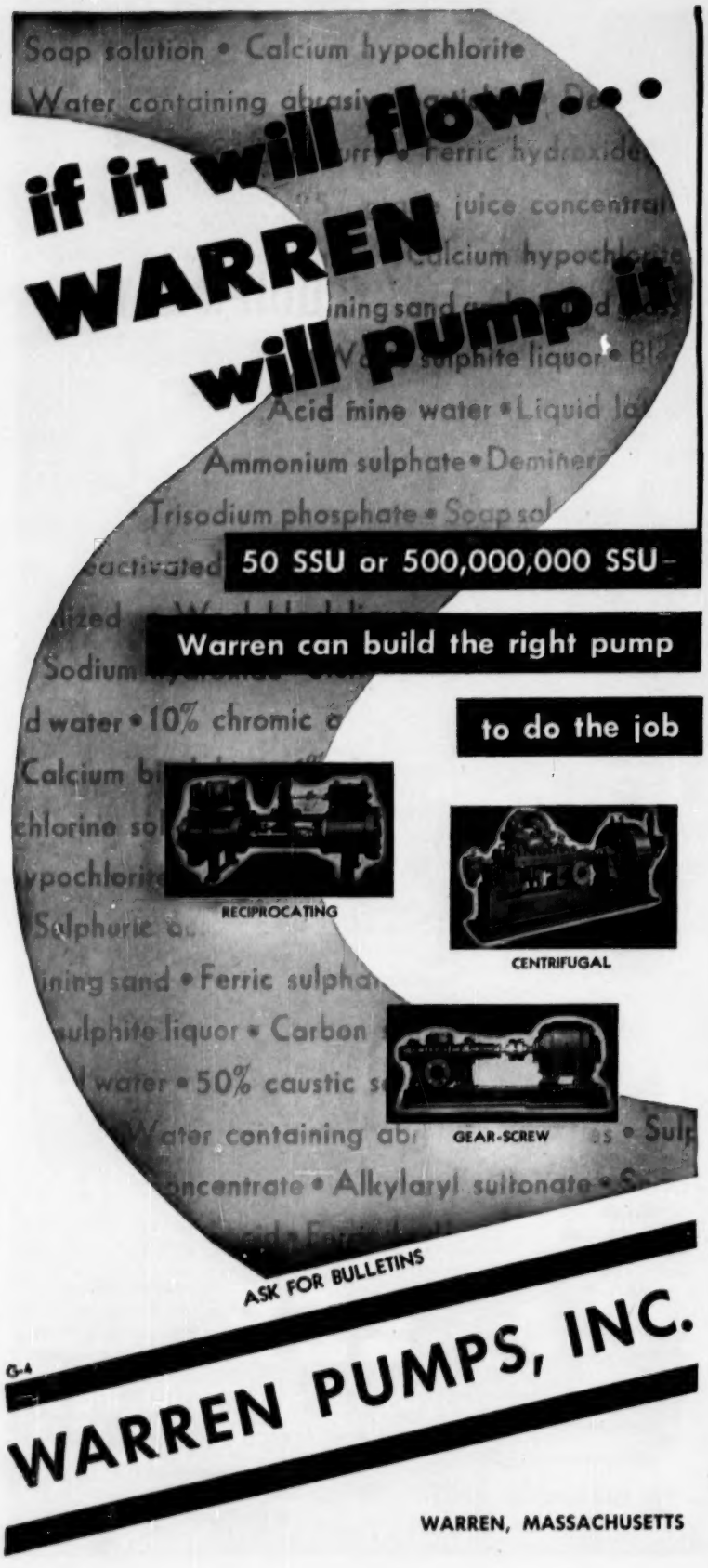
Alex G. Oblad

M. W. Kellogg has announced the election of Alex G. Oblad as a vice president in charge of research and development activities.

The firm, which specializes in the engineering, design and construction of oil refineries and petrochemical plants, chose Oblad because of his concentrated industrial experience in the petroleum field.

Before joining Kellogg, Oblad held the position of vice president in charge of research and development for Houdry Process Corp. He was also a member of the Philadelphia firm's board of directors. Responsibilities, at the same time, involved him in the expansion of Catalytic Construction Co., a Houdry subsidiary.





NAMES . . .

Earlier in his career, Oblad was associated with the Texas Research Foundation, the Magnolia Petroleum Co. and Standard Oil (of Indiana).

Currently, Oblad is editor of publications, division of petroleum chemistry, of the American Chemical Society. He is also on the board of directors of the International Congress of Catalysis.

John F. D'Antonio

Crawford & Russell, Inc., chemical and process plant engineers and constructors, have named John F. D'Antonio manager of their board processes consulting division.

D'Antonio has worked on the design of board plants since 1927. He did much of the design and development work for the Oliver continuous board machine used in insulating board plants.

The Stamford, Conn., firm offers complete engineering services for the design and construction of gypsum, hardboard and insulating board plants.

Dalton J. Appleby, chemical engineer in production and engineering with Electric Reduction Co. of Canada, Ltd., has been named chief engineer in the central engineering department.

Robert Herzog has been named to head up Ethyl Corp.'s economic research staff, in New York. Herzog, a chemical engineer, has been asosciated with the firm for the past 17 years.

Harold W. Catt has been selected to direct rocket activi-

ties at B. F. Goodrich Aviation's new facilities, now in the planning stages, in Rialto, Calif. **A. B. Japs** will be development manager. Both men are chemical engineers.

Thomas H. Arnold, Jr.

Thomas H. Arnold, Jr., has joined Chemical Engineering's staff as an assistant editor.

Arnold is a graduate in chemical engineering from Louisiana State University and has just completed another year of postgraduate work at LSU, with a minor in petroleum engineering.

Tom's industrial experience, largely in the petrochemical field, has been varied. He spent three months in refinery technical service with Esso at Baton Rouge and some eighteen months with Ethyl Corp., also at Baton Rouge. Assignments involved process design, pilot plant operation, technical service to manufacturing, and chemical development.

As a graduate student, Tom spent a year as an assistant to a consulting chemical engineer in the sugar cane industry. Work here involved economic studies, process development and plant design.

From October 1954 until August 1956, Tom was a chemical engineering assistant in the Army Chemical Corps, in Maryland, and at the Pine Bluff Arsenal, in Arkansas. At Pine Bluff, he also worked for nine months as a chemical engineer in process development for Niagara Chemical division, Food Machinery & Chemical Corp.

At school, Tom was president of the student chapter of the AIChE, the sophomore engineering class, and of the college of

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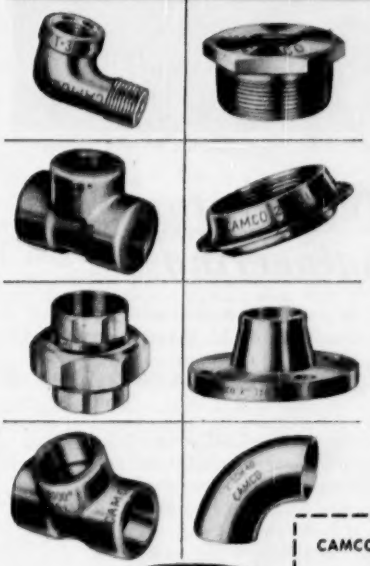

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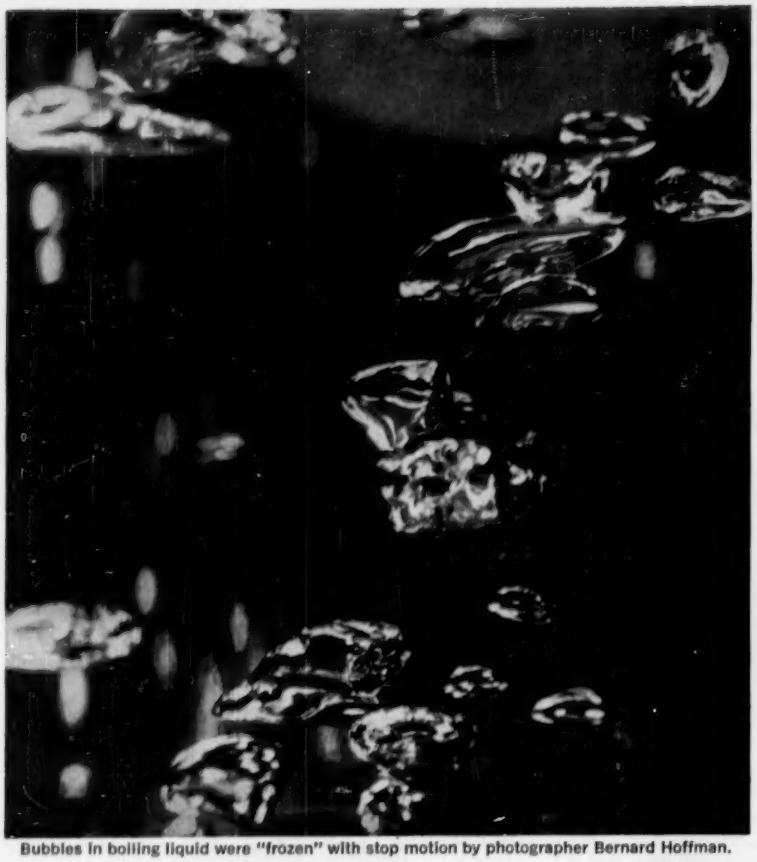

Bubbles in boiling liquid were "frozen" with stop motion by photographer Bernard Hoffman.

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There is a full SMS line – standard R-S Butterfly Valves ready for fast assembly and shipment from stock, Rotovalves and Ball Valves. A call to our nearest representative will bring information. Or, write S. Morgan Smith, York, Pa., for data on standard valves or special applications.

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engineering. He was also vice president of Omicron Delta Kappa, co-valedictorian of the 1951 graduating class, and recipient of honor awards in chemistry, math, and engineering. On top of that, he found time to write two articles for the *Petroleum Refiner* and one for *Chemical Engineering*.

Albert H. Cooper

American Industrial Chemical Co., division of Amerace Corp., has named Albert H. Cooper as general manager.

One of the country's authorities in the silica field, Cooper was in back of the development of the new continuous process now used at the firm's Butler, N. J., plant for the production of silica gel and other silicas.

Past industrial experience includes a post as manager of engineering research and development for Davison Chemical Corp. and similar positions with Pilot Engineering Co. and the Chemecon Corp.

Well known, too, in the field of education, Cooper headed the departments of chemical engineering at the University of Denver, Bucknell University and Pratt Institute. He earned his own chemical engineering degree at the University of Tennessee. Then, he went on to get a doctorate at the University of Michigan. It was awarded to him in 1933.

Cooper is a member of the American Institute of Chemical Engineers, the American Society of Mechanical Engineers, the American Chemical Society, the Electrochemical Society, the American Society for Engineering Education, and the American Management Association.

Edward H. Baxa

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has named Edward H. Baxa manager of the firm's processing machinery department.

Baxa joined Allis-Chalmers in 1941 and has been affiliated ever since with the department he now heads. Since 1953, he had been engineer-in-charge of pyroprocessing machinery.

He is a South Dakota State School of Mines graduate in chemical engineering.

In his new post, Baxa succeeds Robert L. Halsted—who is now general manager of the industrial equipment division.

L. L. Reynolds and **J. E. Rogers,** chemical engineers with Ethyl Corp. in Houston, have been promoted to assistant plant manager and operating supervisor, respectively, at the firm's new San Francisco plant.

R. F. Hopkins, president of the San Jacinto Chemical Co., division of Smith-Douglass, has been elected vice president of Texas City Chemicals, Inc. He'll also head new products research for the firm.

Bruce J. Bennett has been named vice president in charge of production for Lindsay Chemical Co., West Chicago, Ill. **James S. Murray,** assistant to the president, is now a vice president.

A. L. Lindsay, Jr., of Kaiser Enginers' nuclear engineering division has been appointed manager, nuclear engineering dept., Tokyo. He'll leave for Japan immediately to establish the office.

an adams report *NO. 2 OF A SERIES*

RECIRCULATION MAY BE KEY TO FUTURE GROWTH OF CHEMICAL AND INDUSTRIAL PROCESSES

How much water do you need to make: a ton of steel? a ton of synthetic rubber? a ton of bromine? a barrel of beer?

These are not empty questions. They point to a critical problem which confronts management today in its plans for tomorrow. It is more critical than most of us realize . . . for industry today uses as much water as all other users.

Industry's Needs in 1975

Water is vital for chemical and industrial growth. By 1975, industry will require 215 billions of gallons daily. That is a 100% increase over our current industrial consumption . . . more than we currently consume for all uses combined.

Competing for this water will be irrigation farmers and the general public. Their combined needs by 1975 will be up 40 billion gallons a day . . . possibly even more.

What is the Supply Picture

More than 40% of the communities in the United States already have a critical water supply problem. Yet, to meet the 1975 needs, our supply must be expanded by 50%, at an estimated cost of $50 billion.

Indications are that industry is going to have to bear its part of this cost. Certain communities are already moving to place flat water rates on all users . . . regardless of the volume used. Other groups are demanding a national water policy with full Federal Government regulation of natural sources.

Chemical Industry's Stake

Shortage of water can be a most serious threat to the expansion hopes of the chemical industry. A glance at the following table shows why. You need approximately:

20,800	tons	of	water	per	ton	of	Bromine
2,500	"	"	"	"	"	"	Synthetic rubber
830	"	"	"	"	"	"	Viscose rayon
300	"	"	"	"	"	"	Newsprint
208	"	"	"	"	"	"	Smokeless powder
15	"	"	"	"	"	"	Coke from coal

While process refinements may be able to reduce slightly the amount of water needed for each product, the gains will be minor.

Difference Between Use and Consumption

This is best illustrated by the water needed to make a ton of steel. The industrial average is 65,000 gallons (271 tons). In the past, 65,000 gallons of water flowed out of a river through the steel mill and back into the river again for each ton of steel made. In this case, use and consumption are one and the same thing.

On the west coast, a large steel mill now requires only 1,100 gallons of makeup for each ton of steel produced. This steel mill has its own recirculation system which holds several million gallons of water.

This water is recirculated at a rate equal to 65,000 gallons per ton of steel produced. The only water consumed is that lost due to evaporation or through leakage. Thus, net consumption has been reduced to 1,100 gallons.

Two Bulletins Available

One of the most important pieces of equipment in a recirculation system is a filter. Where high quality process water is needed, diatomite filters will provide an effluent second only to distilled water. Bulletin 651, released by the R. P. Adams Company, Inc., 507 E. Park Drive, Buffalo 17, N. Y., covers this type of industrial water filter.

A second publication, Bulletin 909, covers an Automatic Water Filter which is frequently used in recirculation systems where the water is used for less critical applications. This bulletin is also available on request from the R. P. Adams Company at the above address.

By the way, it takes almost two tons of water to brew a barrel of beer.

SEE US AT THE CHEMICAL SHOW, BOOTH 836

R. P. ADAMS COMPANY, INC.
207 E. PARK DRIVE
BUFFALO 17, NEW YORK

DS7

We have a problem involving liquid filtration. Ask your local representative to call on us.

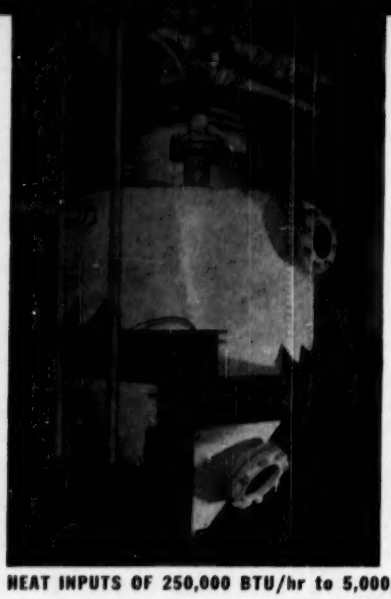
Name_____ Title_____

Company_____

Street_____

City_____ State_____

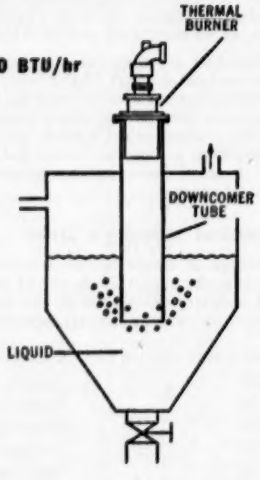
THERMAL
SUBMERGED COMBUSTION



simplicity of design and construction... *plus* extreme compactness

HEAT INPUTS OF 250,000 BTU/hr to 5,000,000 BTU/hr

The high heat release rate of the THERMAL High Velocity burner used in these submerged combustion installations allows the use of a simple downcomer tube through which the products of combustion are discharged beneath the surface of the liquid. This arrangement is possible because combustion is 90% completed within the burner proper. The THERMAL burner is completely separate from the liquid being heated and maintenance, control and accessibility are greatly simplified. Equally simple arrangements are possible with gas, oil or combination fuel.



BROAD RANGE OF APPLICATIONS

Depending upon the material being heated either a metal or refractory downcomer tube may be used. Some of the more common applications are pickling baths, acid concentration, caustic soda concentration, aluminum sulphate concentration, water recarbonization, and glass frit and molten salt heating.

WRITE FOR BULLETIN #110

OTHER THERMAL PRODUCTS & SERVICES → Gas, Oil & Combination Burners • Air Heaters • Combustion & Heat Transfer Equipment

THERMAL
Thermal Research & Engineering Corp.
CONSHOHOCKEN • PENNSYLVANIA
REPRESENTATIVES IN PRINCIPAL CITIES

NAMES . . .

A. L. Schultz

B. F. Goodrich Chemical Co. has named A. L. Schultz manager of rubber chemicals development center at the firm's development center at Avon Lake, Ohio.

Schultz joined the firm in 1942 as a shift foreman in a synthetic rubber plant. Soon after he worked as a process engineer and later as development supervisor. Recently, he organized the first group of technical economists within BFG Chemical to evaluate chemical processes. Later, he supervised chemical process development on several projects.

A native of Palm, Pa., Schultz now lives in Oberlin, Ohio. He holds membership in the American Institute of Chemical Engineers and in the American Chemical Society.

In his new post, Schultz succeeds Edwin W. Harrington—who recently became plant manager of the company's Akron, Ohio, chemicals plant.

R. Emerson Lynn, Jr., has been named manager of chemical engineering research at the B. F. Goodrich Center, Brecksville, Ohio.

Marx M. Weech has returned to the atomic energy division of Phillips Petroleum Co. as assistant to the CPP technical branch manager for special projects. **John H. Clark** and **Sidney Cohen,** both chemical engineers, have joined the firm to work in reactor engineering.

Robert B. Scrimgeour has been appointed manager of the chemical sales department for Pfaudler Co., Rochester,

N. Y. He is a chemical engineering graduate of Drexel Institute.

Edwin M. Kinderman has been named assistant manager of Stanford Research Institute's nuclear engineering section, Menlo Park, Calif.

James McDonald, assistant manager of Tidewater Oil's Delaware refinery, has been advanced to the post of administrative manager of manufacturing. Headquarters are in San Francisco.

R. Lindley Murray

The Sixth Annual Professional Achievement Award of the Western New York section, American Institute of Chemical Engineers, was presented to Robert Lindley Murray during a banquet at the Sheraton-Brock, Niagara Falls, Ont., on October 17.

Murray is president and chairman of the board of Hooker Electrochemical Co. as well as president and director of both Hooker Chemicals, Ltd., North Vancouver, B. C., and Marble Nye Co., Worcester, Mass.

The award was made to Murray for his service to the AIChE and particularly to the local Western New York section as well as in recognition of his outstanding engineering and executive ability. Murray is one of the original founders and a past chairman of the section.

Besides serving on many of the local section's committees, Murray has twice been elected a director of the national AIChE —racking up a total of six years in office.

Murray joined Hooker at Ni-

(Advertisement)

E-D Filter Paper Makes Excellent Cover For Cloth Or Other Filter Media

Provides Greater Clarity Of Filtration And Prolongs Life Of Filter Medium

FILTERTOWN, USA. Field reports prove that there is an increasing use of E-D filter papers, with the greatest demand for grade # 953, as a cover for cloth or other filter media in industrial filtration, To date, this practice has been widely adopted in plants which process oils, including coconut, cod liver, corn, cooking, linseed, soybean, and vegetable oil. These plants manufacture margarine, salad oil and shortening, soaps, paint, varnish, and many other products.

Great Savings In Time And Money

Actual experience, in hundreds of cases, has proven to the satisfaction of production officials that it is far more economical to cover the cloth or other filter medium with E-D filter paper and then, when the press needs redressing, to simply peel off the paper, discard it, and replace with a clean E-D filter paper cover. Substantial savings in press running time are made.

E-D filter paper holds up solid particles to such a degree that there is often little need for recirculating the slurry to obtain an adequate cake deposit for clear filtration at the start of a cycle.

Moreover, the E-D filter paper protects the filter medium from slimy fines, thus prolonging its useful life, saving additional money on media expenditures. The cost of E-D filter paper is so little, in comparison with the cost of other filter media, that these savings are important.

Greater Clarity Of Filtrate Obtained

Because of its fine porosity and unique uniformity of furnish, grade #953—as well as the many other grades of E-D filter paper—obtains exceptional clarity of filtrate. Many degrees of rapidity and porosity are available in the more than 50 regular grades manufactured by The Eaton-Dikeman Company. Special grades are also made to meet individual requirements.

Free Samples Available

Actual tests made at the user's plant furnish convincing proof of the many advantages that are possible. Simply write for E-D's Filtration Analysis Report. When the necessary facts are supplied, you will receive several recommended grades, cut to your own size and specifications, at no charge. Make the necessary test runs and you will soon be able to determine the benefits for yourself. There is no charge or obligation for this service.

Write to Thomas H. Logan, Jr., care of The Eaton-Dikeman Company, Filtertown, Mount Holly Springs, Pennsylvania for prompt attention.

This company is the only company in America that is exclusively engaged in the manufacture of filter paper for science and industry. Authorized representatives and dealers are located in every section to provide service and helpful information on all problems relating to liquid filtration.

HAZARDOUS CONDITIONS?

J-95
J-96

Use UE Explosion Proof
PRESSURE-VACUUM CONTROLS

The Types J95 and J96 Pressure-Vacuum Controls are designed for applications in hazardous locations where explosive vapors or gases are present and close on-off differential control is required. In both units, pressure settings are uncalibrated and adjustment is made by an internal nut.

Adjustable Range	J95 — Various ranges between 0 and 500 psi limits. J96 — Various ranges between 0 and 180 psi limits.
Switch Differential	J95 — Factory pre-set for any differential between 2 and 30 psi. J96 — Factory pre-set for any differential between 3" W.C. and 2 psi.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. swtiches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
Maximum Pressure	J95 — Up to 600 psi. J96 — Up to 180 psi.
Electrical Connections	J95 — Lead wires attached to screw type terminals on switch via ½" NPT opening. J96 — Lead wires attached to terminal block via ¾" NPT opening.
Pressure Connection	Via a ¼" female NPT connection.
Enclosure	J95 — Cast iron with a gray, baked-enamel finish. For use in Class I, Groups C and D locations. J96 — Cast iron base and aluminum cover. For use in Class I, Group D; Class II, Groups E, F, and G; or Class III locations.
Mounting	Surface-mounted by four corner holes with clearance for ¼" screws.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For information on modifying standard units or providing custom-built units, consult a UE application engineer. For additional data on the Types J95 and J96, request new literature available.*

UE®
United Electric Controls
COMPANY
84 SCHOOL STREET WATERTOWN, MASS

NAMES . . .

agara Falls, N. Y., in 1916, as a research chemical engineer. He assisted in running a Hooker-operated explosives plant for the Government during the World War I and later became manager of research, plant superintendent, chief engineer, director of development—in that order. In 1941, he was named vice president in charge of development and research; executive vice president, in 1949; president, in 1951.

He was elected to his present post as chairman of the board in 1955 while continuing as chief executive officer of the company.

The Murrays live in Lewiston Heights, Lewiston, N. Y.

Joseph W. Lewis

Beckman Instruments, Inc., has announced the appointment of Joseph W. Lewis as an assistant to the president.

For the past six months, Lewis has been manager of Arnold O. Beckman, Inc., South Pasadena, Calif. Prior to that time, he was associated for some ten years with U. S. Steel Products Co., where he served as manager of industrial relations and later as assistant to the West Coast vice president and general manager in Los Angeles.

During the school year 1943-44, Lewis taught industrial relations courses at Caltech under the government's Engineering Science Management War Training Program. He earned his own B. S. degree at Caltech in 1941 and became president of the school's alumni association in 1948.

Robert B. Agee has joined the research and development de-

partment of Ethyl Corp., Baton Rouge, La., as a chemical engineer.

Charles L. Woods, Jr., is now plant engineer for the Louisville, Ky., plant of B. F. Goodrich Chemical Co. Woods succeeds **Russell C. Grover,** recently named as plant engineer at the firm's new Henry, Ill., plant now under construction.

George B. Kirk has been named director of research and development for Kaiser Gypsum Co., Oakland, Calif. He had been field service manager.

G. Warren Crockwell has been appointed technical service supervisor of silicone rubber for Union Carbide's silicones division. He's stationed at the Tonawanda, N. Y., laboratories.

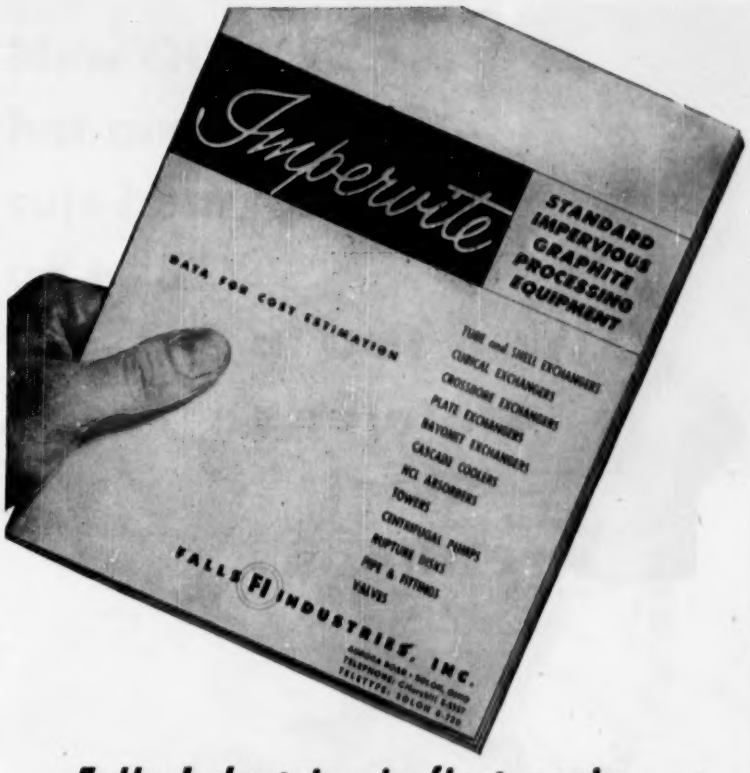
John MacPherson, William B. Wandel and **Ahmed Kianpour** have joined the research department of Monsanto Chemical Co.'s Texas City, Tex., plant. **J. M. Boyd** was assigned to the production technical service department.

OBITUARIES

David Spence, who developed a number of important processes in the rubber field, died September 24 at his home in New York. Spence was a director of research and development of the Diamond Rubber Co. and B. F. Goodrich Co. from 1909 to 1914.

Albert G. Davis, a chemical engineer for the Kellogg Oil Co. of N. J., died September 20 at Elizabeth General Hospital, Elizabeth, N. J.

Hoyt R. Crabaugh, 40, acting chief engineer for the Los Angeles County Air Pollution Control District, died in a Long Beach, Calif., hospital as a result of injuries suffered in a small boat collision. Crabaugh earned his degree in chemical engineering from the University of Southern California in 1947.



Falls Industries is first again...

with Comprehensive Data for Cost Estimation of Impervious Graphite Processing Equipment

This 32 page report presents costs and equipment specifications on all the standard impervious graphite processing equipment produced by Falls Industries. Equipment is illustrated with drawings, diagrams or photographs. Costs are tabulated in dollars per square foot of heat transfer surface, or other convenient unit.

Also covered in this report are the famous IMPERVITE impervious graphite Rupture Disk, and the IMPERVITE CROSS-BORE heat exchanger—the most recent exclusive developments of Falls Industries.

The following unsolicited comments are typical of the many received:

"This is exactly the type of information we like to get with costs included."

"It presents the most comprehensive picture of equipment data issued on the subject."

Follow the responsible leadership of Falls Industries for practical development of better processing equipment, and greater service.

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New production machinery and techniques developed at W-S Fittings Division now assure you of prompt deliveries on corrosion resistant stainless steel pipe fittings. Your local W-S stainless steel distributor will be glad to fill your order from his stock.

W-S 150 lb stainless steel fittings, types 304 and 316, resist a wide variety of corrosive services in petroleum, chemical, petrochemical, food and other process industries. They are also ideal for many low temperature operations because of their inherent toughness at sub-zero conditions. W-S 150 lb fittings can be obtained in sizes ⅛" to 4" in either screwend or socket-welding types to meet your needs.

For detailed technical information on our 150 lb line, send today for Bulletin S-3-55. For prompt price and delivery information call your nearest W-S distributor.

Write to W-S Fittings Division, H. K. Porter Company, Inc., P.O. Box 95, Roselle, N. J.

H. K. PORTER COMPANY, INC.
W-S FITTINGS DIVISION

PEOPLE . . . FIRMS IN

NEW LOCATIONS

Douglas Oil Co. of California has moved executive and sales offices to 815 W. Fifth St., Los Angeles, Calif.

U.S. Industrial Chemicals Co. has relocated offices of its Pacific Coast Div. New address: 1901 W. Eighth St., Los Angeles 57, Calif.

Magnetic Instruments Co. has moved all operations to a new plant at 546 Commerce St., Thornwood, N. Y.

NEW FACILITIES

Lion Oil Co., division of Monsanto Chemical Co., will add a 5,000-bbl./day catalytic reformer and a hydrodesulfurization unit at its El Dorado, Ark., refinery.

Lunn Laminates Inc., reinforced plastics fabricator, has acquired a fourth plant in Huntington Station, N. Y. New 32,000-sq. ft. plant will manufacture Navy landing craft.

Pacific Vegetable Oil Corp. is building a $135,000 office and laboratory building at Richmond, Calif. Company has also increased capacity of vegetable oil processing facilities at its Richmond and Los Angeles plants.

Standard Oil Co. of California is spending more than $1 million on projects at La Habra, Calif.: 17,000-sq. ft. research laboratory, 41,000-sq. ft. exploration department building, cafeteria additions.

Foster Grant Co. is expanding its Baton Rouge, La., styrene monomer plant to 105 million lb./yr. Company is also slated to open a new high-impact polystyrene plant at Leominster, Mass.

Standard Oil Co. (Ind.) has come on stream with a new

THE NEWS

J. B. BACON

catalytic alkylation plant at the Sugar Creek, Mo., refinery. Unit's capacity is 160,000 gal./day high-octane gasoline.

Standard Oil Co. of California has set Dec. 15 as completion date for new 300-bbl./day natural gasoline deisobutanizer at the El Segundo, Calif., refinery. Cost: $250,000.

Atlantic Refining Co. has contracted with Fluor Corp. for installation of a 2,100-bbl./day alkylation unit in its Port Arthur, Tex., refinery. Atlantic has new 15,000-bbl./day Unifiner-Catformer units on stream at the Port Arthur and Philadelphia, Pa., refineries.

Texas Co. is now operating its new 20,000-bbl./day refinery at Santiago, Cuba. Costing over $15 million, refinery produces gasolines, kerosene, diesel oil, fuel oil and liquefied petroleum gas.

National Petro-Chemical Corp. has started construction of a $20-million polyethylene plant near Houston, Tex. Capacity will be 75 million lb./yr. polyethylene from modified high-pressure process. Phillips Petroleum will supply ethylene; M. W. Kellogg Co. is building.

Glidden Co. and Industrias Quimicas Basicas of Mexico are jointly planning a $6.4-million titanium dioxide plant to be built at Vera Cruz, Mex.

Parke-Davis is constructing a new branch office in Kansas City. Scheduled for occupancy in July 1958, building will have 31,000 sq. ft. floor space.

Commerce Oil Refining Corp. has hired Fluor Corp. to engineer and build a 43,000-bbl./day refinery at Jamestown, R. I. Located on a 600-acre site, refinery will produce high-octane gasoline. Completion is slated for summer

New QUAKER hose for hot air ducting cuts heat loss up to 57%

OUTSIDE JACKET SURFACE TEMPERATURE (DOUBLE JACKET) 170°F.
OUTSIDE JACKET SURFACE TEMPERATURE (SINGLE JACKET) 235°F.
INSIDE AIR TEMPERATURE 450°F.

Synthetic fabric jacket and silicone tube retain temperatures from upstream to downstream end

Made in continuous lengths up to 50', this new Quaker hose easily withstands temperatures as high as +450°F; as low as −80°F.

As the above diagram shows, the hose keeps heat loss—and therefore energy loss—to a minimum. (Comparable outside temperature of ordinary hot air ducting material, such as stainless steel, would be about 400° F.). Both the silicone tube and the synthetic fabric jacket of Quaker's new hose hold the heat!

Other advantages? The hose is lightweight and fully flexible. And it resists abrasion.

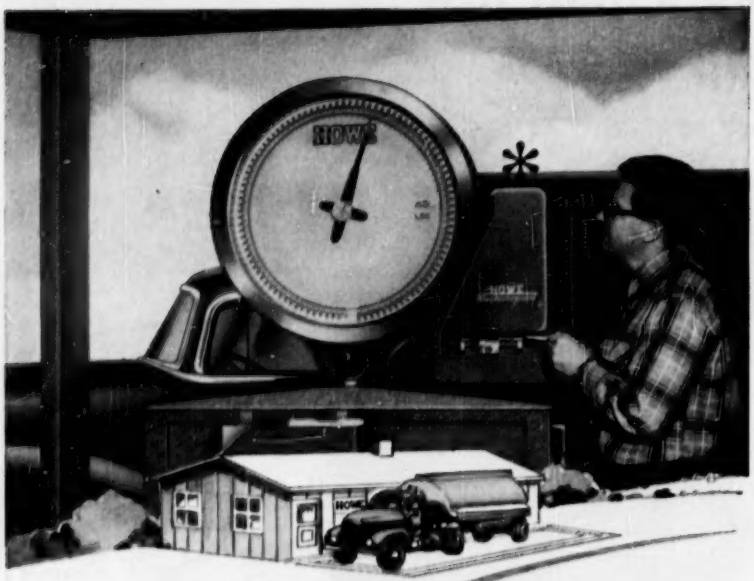
Available in either single or double jacket, the hose comes in 1" to 4" I.D.'s. Sizes 1" and 1¼" I.D. can be made in 30' continuous lengths; 1½" to 4" I.D. in 50' lengths. The hose takes regular expansion and shank hose couplings.

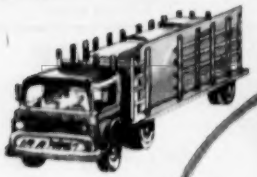
H. K. Porter Company, Inc.,
Quaker Rubber Works,
Philadelphia 24, Pa.
Pioneer Works,
Pittsburg, Calif.

H. K. PORTER COMPANY, INC.
QUAKER RUBBER DIVISION

WEIGHT CONTROL IS COST CONTROL

and this scale saves money on every weighing!





HOWE MOTOR TRUCK SCALES

Unique construction guarantees longer life, more accurate weighing for rigid cost control. 2 and 4 section models, capacities to 50 tons, lengths to 60 feet. Find out how this scale—and other Howe equipment—can speed your weighing, cut your costs, increase your profits.

* PRINTED WEIGHT RECORDS!

The Howe Mechanoprint® ticket shows gross, tare and net weights. Avoids errors, provides permanent records.

Write for Complete Details

HOWE

THE HOWE SCALE CO. · RUTLAND, VERMONT

A SUBSIDIARY OF SAFETY INDUSTRIES, INC

FIRMS . . .

1959; cost will exceed $50 million.

Crown Can Div. of Crown Cork & Seal Co. is expanding aerosol can facilities at its Philadelphia, Pa., plant. Program is running into "six figures."

Allied Chemical & Dye Corp. is upping capacity at its Hopewell, Va., caprolactam plant to 60 million lb./yr. Caprolactam is the monomer for nylon-6.

Infilco Inc., manufacturer of water-treating equipment, has opened a new 40,000-sq. ft. foundry and manufacturing plant in Salem, Ill. Company has also added 10,000 sq. ft. of office space at its Tucson, Ariz., headquarters.

Du Pont of Canada Ltd. announced an additional $4-million expansion of its Maitland and Kingston, Ont., plants; $3 million at Maitland goes for powerhouse and process expansion; $1 million at the Kingston nylon spinning plant goes for additional warehousing space.

Crescent Carbon Corp. is operating its new 2,500-ton hydraulic extrusion press, makes large-diameter synthetic graphite electrodes for steel furnaces.

Ashland Mining Co. plans to build a low-grade iron ore pellet plant near Butternut, Wis. Plant will cost $50 million and employ 500 when completed.

Morningstar, Nicol Inc. has added a food developments laboratory at Hawthorne, N. J. Lab will develop uses for company's line of starches and natural gums.

Barada & Page Inc. is spending $250,000 for 20,000 sq. ft. of new office and warehouse facilities in Houston, Tex.

Dominion Tar & Chemical Co. will have a new tar distillation plant in Hamilton, Ont., by summer 1958. Unit will process 15 million Imperial

gal./yr. tar to produce solvent, tar acid oil, napthalene oil, creosote and pitch products.

Firth Sterling Inc. is now manufacturing carbide products from its new tungsten carbide sintering plant in Los Angeles, Calif.

Westvaco Mineral Products will produce dichlorocyanuric acid, trichlorocyanuric acid and the sodium salt of dichlorocyanuric acid from a new Charleston, W. Va., plant slated to be in operation in July 1958. Capacity: 6 million lb./yr. of these dry bleach products.

Union Carbide Corp.'s Mexican affiliate, Electrodos Nacionales, S. A., is building a graphite electrode plant near Monterrey, Mex. Operation is slated for 1958.

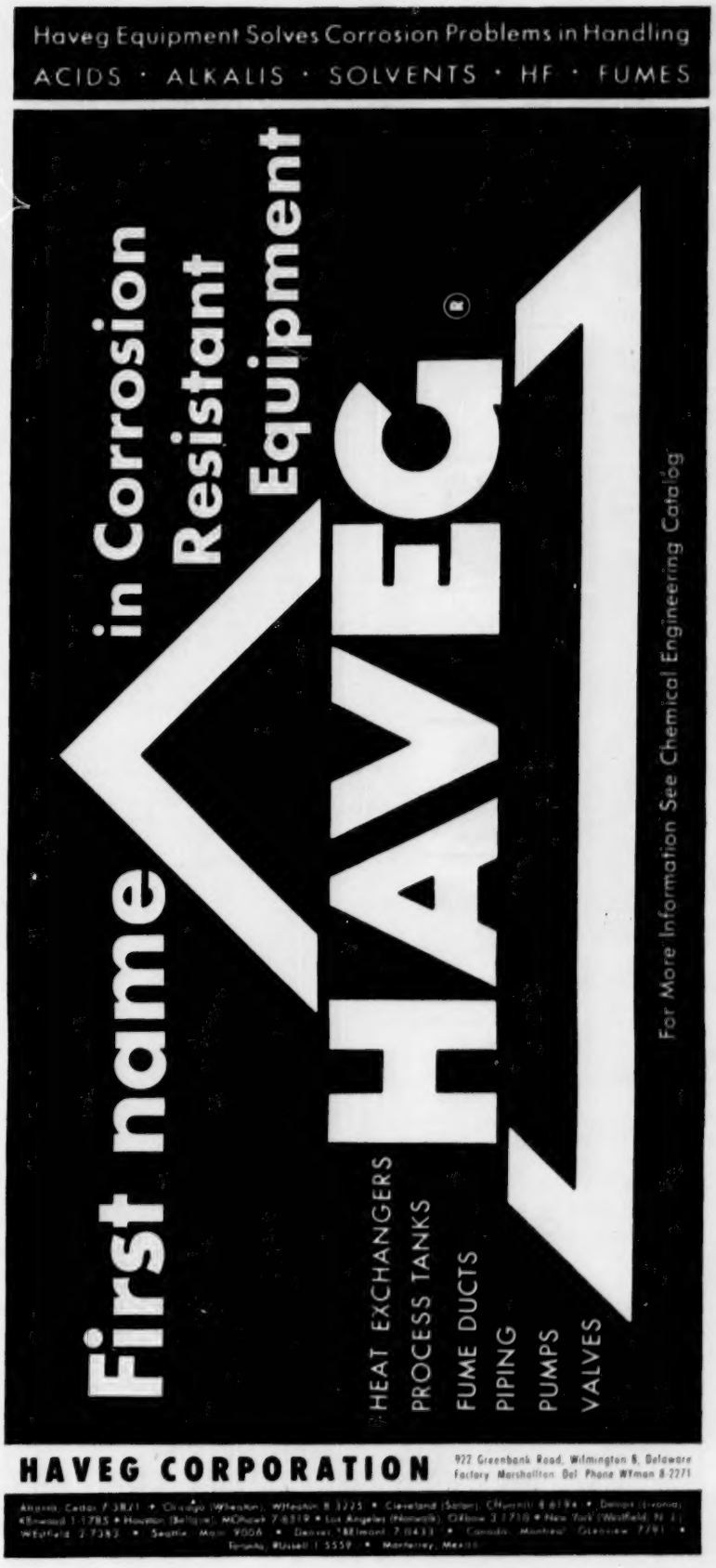
Freeport Sulphur Co. has signed Frederick Snare Corp. to construct facilities for mining and concentrating nickel-cobalt ores at Moa Bay, Cuba. Cost of project will be $75 million; output of plant will be 50 million lb./yr. nickel and 4.4 million lb./yr. cobalt. Completion is called for by July 1959.

Sun Oil Co. is now housing its research and development personnel in a new $2.5-million laboratory recently completed at the Marcus Hook, Pa., refinery.

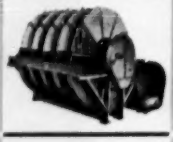
Flintkote Co. has entered the gypsum field with the recent opening of its gypsum products plant in Sweetwater, Tex.

Standard Oil Co. (Ind.) has a new 21,000-bbl./day Ultraformer on stream at its Whiting, Ind., refinery. Also on stream is new 60,000-bbl./day pipe still.

Esso Nederland N. V. will spend $50 million upping capacity of the Rotterdam, Netherlands, refinery from 14 million to 31.5 million bbl./yr. Badger-Comprino N. V. at The Hague, partly owned by



DENVER PROCESS EQUIPMENT

DENVER (patented) **SUPER AGITATORS and MIXERS**		3'x 3' to 20'x 20'	Patented standpipe around propeller shaft assures positive agitation and circulation. Patented wearing plate prevents sand-up on shut-down. Heavy duty as well as acid-proof construction is available in both open-type, air lift and Super Agitator models. Please write for Bulletin No. A2-B4.
DENVER Steel-Head **BALL MILL**		3'x 2' to 8'x 20'	A Denver Steel-Head Ball Mill will suit your particular need. Five types of discharge trunnions. All-steel construction. Low initial cost due to quantity production. Quick delivery. Laboratory and pilot plant mills also available. Please write for Bulletin No. B2-B13.
DENVER Automatic **SAMPLERS**		16" to 60" Cutter Travel	Heavy duty units, extra rigid track and ball-bearing wheels assure positive travel and timing of sample cutter. Available in stainless steel for acid and corrosive service. Wet and dry cutters. Central Control Panel for multiple samplers. Bulletin No. S1-B4.
DENVER Forced-Feed **JAW CRUSHER**		2¼"x 3½' to 36"x 48"	Cast Steel Frame, manganese jaw and cheek plates. Large diameter shafts reduce shaft deflection and thus increase life of heavy-duty, oversize roller bearings in bumper. Setting easily controlled. Please write for Bulletin No. C1½-B12.
DENVER Wet Reagent **FEEDER**		0 cc to 2000 cc	Accurately meters minute quantities of liquid from 0 cc to 2000 cc per minute. Float valve in tank permits connection of feeder to bulk storage device. Handwheel adjustment to control amount of liquid is simple and accurate. Used in multiples for higher capacities. Please write for Bulletin No. F6-B9.
DENVER Disc **FILTER**		1 Disc, 2' to 12 Disc, 9'	Special, patented design of segments in Denver Disc Filters use both gravity and vacuum to give a drier filter cake. Drainage is complete and positive, with no blow-back. Simple, low-cost, dependable construction. Quick delivery. Also Drum and Pan Fillers. Please write for Bulletin No. FG-B1.
DENVER "Sub-A" **FLOTATION**		Laboratory and Commercial	Flotation is the selective separation of particles from each other in a liquid pulp by means of air bubbles. More large plants are installing Denver "Sub-A's" for their entire flotation job, because they give maximum recovery at a low cost per ton. Dependable, low-cost, simplified continuous operation. Please write for Bulletin No. F10-B81.
DENVER Wilfley Concentration **TABLES**		5 to 150 T/24 Hrs.	A mechanically operated, longitudinally reciprocating table consisting of a deck having a plane surface partly riffled and a tilting device. It separates materials into bands and handles the coarsest sands with excellent results. Ideal for separation of groups of particles having a similar range of specific gravities. Write for Bulletin No. T1-B3.
DENVER LABORATORY EQUIPMENT		Batch or Continuous	Batch and continuous test models of Crushers, Screens, Ball Mills, Pulverizers, Rod Mills, Classifiers, Agitators and Mixers, Pulp Distributors, Feeders, Flotation Machines, Pumps, Thickeners, Filters, Dryers, Tables, Samplers. Results obtained on Denver Laboratory Equipment can be duplicated by commercial machines. Please write for Bulletin No. LG3-B10.
DENVER Standard **DRYERS**		2'x 15' to 5'x 40' and larger	Available in several types: Direct Heat, Indirect Heat, and Steam Tube. Let DECO Engineers solve your drying problem. No dryer problem too small or too large. Please write for Bulletin No. D4-B2.

"The firm that makes its friends happier, healthier and wealthier"

DENVER EQUIPMENT COMPANY

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See Our New Catalog Starting on Page 647 CEC

FIRMS . . .

Badger Mfg. Co., will engineer and build.

NEW LINES

Diamond Alkali Co. is now producing USP-grade calcium carbonate at its Painesville, Ohio, plant.

Dow Chemical Co. has established Tyril as name of its line of styrene-acrylonitrile copolymers. Styrex 767 is now called Tyril 767.

New Zealand Rubber Mills Ltd. in Auckland, New Zealand, will produce polyurethane foam, called Reidoprene, under license from German firm of Farbenfabriken Bayer.

Canadian Resins and Chemicals Ltd., subsidiary of Shawinigan Chemicals and Union Carbide combine, will sell chemicals for plastics and lacquer industries under exclusive license from Badische Analin-und Sodafabrik of Germany.

MERGERS & ACQUISITIONS

Ogden Corp. has acquired Eimco Corp. and American Foundry and Machine Co., both of Salt Lake City, Utah. Eimco manufactures heavy equipment; American Foundry and Machine produces many of the castings used by Eimco.

Douglas Oil Co. of California has acquired 98.8% of the common stock of Apex Petroleum Corp. and will operate the firm as a subsidiary.

Haveg Industries, Inc. will operate Reinhold Engineering and Plastics Co. as a wholly owned subsidiary. Reinhold, which Haveg recently acquired, produces and fabricates plastics for aircraft missile industry.

Neptune Meters Ltd. of Toronto, Ont., has purchased all outstanding stock of Cleveland Meters Ltd., England; gives Neptune its first overseas manufacturing operation.

General Waterworks Corp. has purchased Natrona Water Co. from Pennsalt Chemicals Corp.

Liquid Carbonic Corp. has merged into General Dynamics Corp.; Carbonic will retain its identity and organizational structure but will operate as a member of General Dynamics.

Fulton-Denver Co. has purchased Fulton Bag & Cotton Mills' textile bag manufacturing branch in Denver, Colo.

NEW COMPANIES

Fluor Engineering and Construction Ltd. has been established in London, Eng., as a wholly owned subsidiary of Fluor Corp.; will service rapid expansion of European petroleum and petrochemical industries.

Harco Engineering Co. has been formed in Los Angeles, Calif., to offer engineering service for construction of chemical and petroleum plants.

Atlas Metal Protection Inc., specializing in corrosion prevention and control services for petroleum and chemical industries, has been formed as a wholly owned subsidiary of Atlas Pipe of Houston, Tex.

NEW NAMES

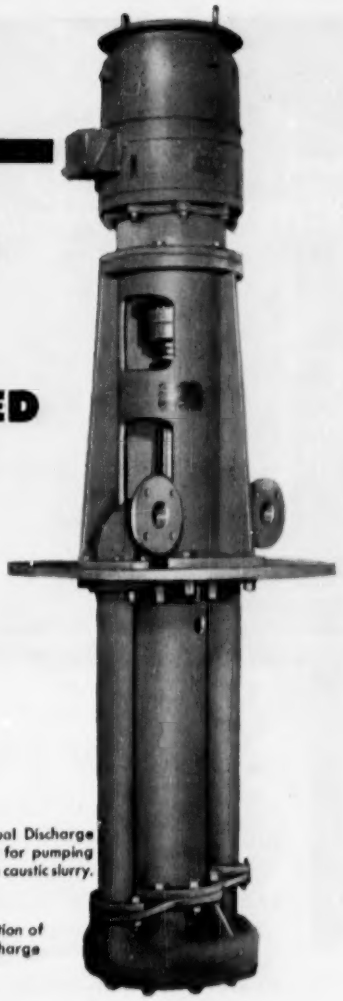
Hoechst Chemical Corp. in West Warwick, R. I., is the new name of Metro Dyestuffs Corp., U. S. subsidiary of Germany's Farbwerke Hoechst.

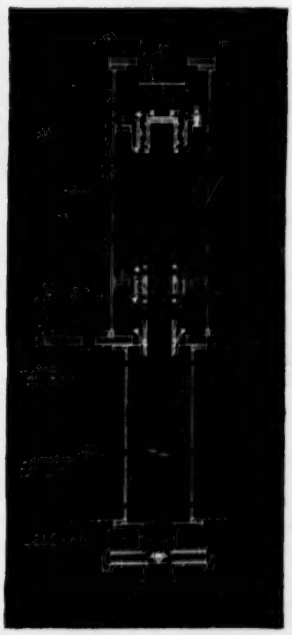
Continental Diamond Fibre of Canada is now the name of Diamond State Fibre Co. Firm manufactures industrial laminates in Canada.

Instrument Division of Robertshaw-Fulton Controls Co. is name of organization formerly known as the Fielden Instrument Div.

Petrofina (Gt. Britain) Ltd. is new name of Fina Petroleum Products Ltd.

VERTICAL PUMPS WITH NO SUBMERGED BEARINGS FOR PUMPING ABRASIVE CORROSIVE SLURRIES





2" Dual Discharge Pump for pumping molten caustic slurry.

Cross section of Dual Discharge Pump.

This rugged type of service calls for advanced design — extra heavy shaft, double-ported casing to equalize the side thrust of the impeller, and tough abrasion-corrosion resistant alloys. The dual discharge pump illustrated here incorporates these features and dispenses with bearings or packing below the cover plate where they would be in contact with the liquid.

Difficult pumping problems, particularly in the process industries, have been our specialty for ninety-one years. Perhaps we can be of help to you. Write us — no obligation.

LAWRENCE PUMPS INC.

Write for Bulletin 203-7 for Complete summary of acid and chemical pump data.

375 Market Street, Lawrence, Mass.

one pipe insulation... **UNIBESTOS**

for every temperature from 80° to 1200° F.

UNARCO

See how you save!

INVENTORIES SIMPLIFIED—only one type of insulation to stock.

EASIEST TO APPLY—standard methods, regular tools; cuts quickly without shattering or end-breakage. Refractory-coated smooth surface.

RESISTS IMPACT—virtually impervious to shock and vibration. Built to stay strong indefinitely.

WITHSTANDS MOISTURE, FUMES—insulating capacity is unchanged by long exposure to various chemical fumes. Submerged in water for weeks, it dries good as new.

POSITIVE HEAT-LOSS PROTECTION — No shrinkage; calcination and dehydration practically eliminated.

LOW THERMAL CONDUCTIVITY—means high insulating efficiency.

HEAT-TIGHT JOINTS—the fibrous nature of Unibestos leads to interlacing between sections for effective heat-sealing of joints.

SINGLE-LAYER APPLICATION—tests prove less heat loss with single-layer UNIBESTOS than with other double-layer insulations.

There's nothing like UNIBESTOS

If you're not using UNIBESTOS now, it's time to take a new look at pipe insulation. Costs come down all along the line with this all-purpose, long-lasting protection.

UNIBESTOS is quickly adapted for flanges, valves, fittings—needs no canvas cover, no additional protection within buildings. Shrinkage is negligible, even at 1200°, and it may be removed and re-used time after time without damage or loss of efficiency.

Long the world's largest selling high-temperature pipe insulation, today's UNIBESTOS is the one *all-temperature* pipe insulation. It costs no more, and only *one* insulation need be stocked on the job.

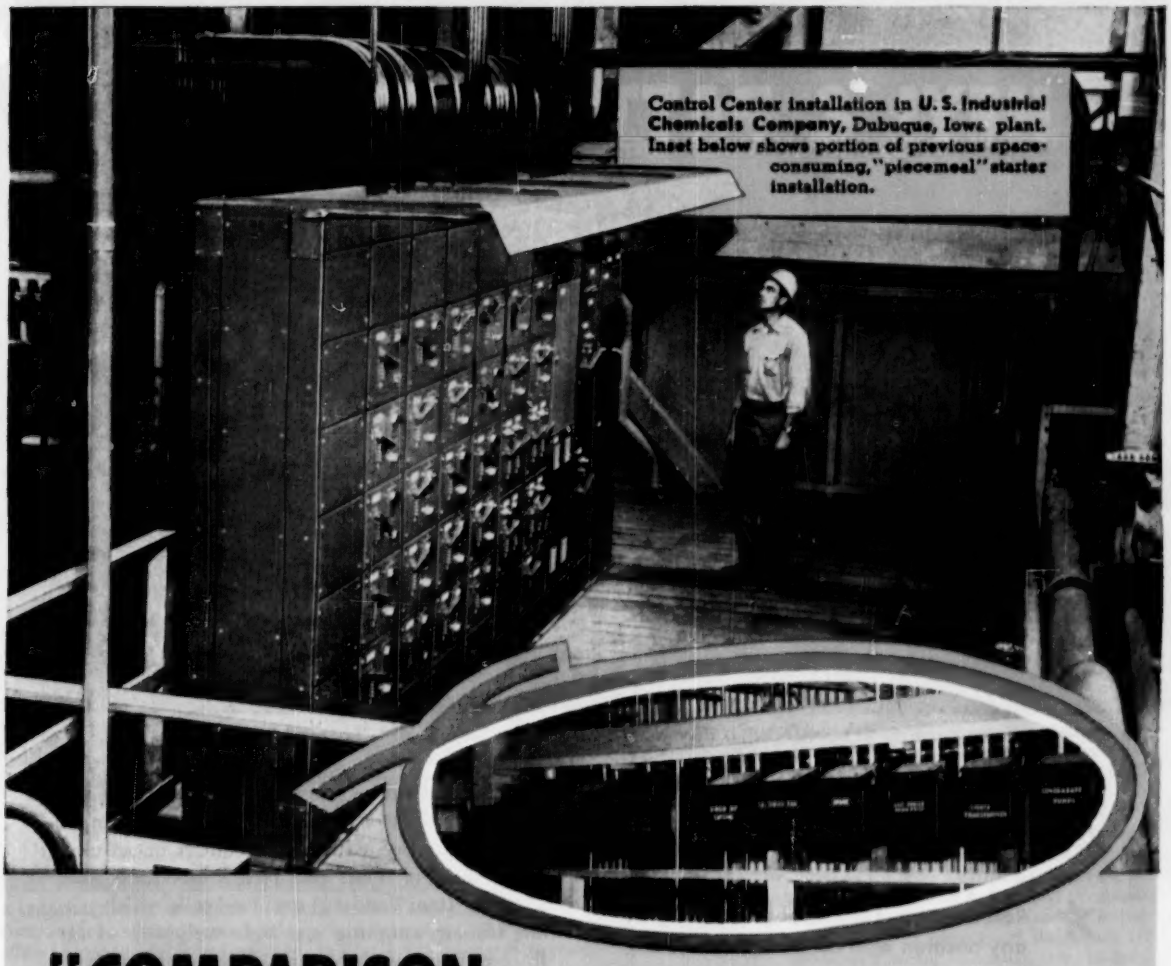
Small and thin or big and thick, sizes to 44" O.D. Made from long-fibered Amosite asbestos. UNIBESTOS assures outstanding economy, whatever the service or temperature.

HOW THICK SHOULD PIPE INSULATION BE?

Ask for UNARCO'S free 40-page Booklet F76-312 with exclusive "J" Factor Tables for easy, scientific thickness selection according to cost of fuel, hours of operation, life expectancy of installation, pipe size, temperature, and cost of insulating.

UNION ASBESTOS AND RUBBER COMPANY

1111 West Perry Street, Bloomington, Illinois



Control Center installation in U. S. Industrial Chemicals Company, Dubuque, Iowa plant. Inset below shows portion of previous space-consuming, "piecemeal" starter installation.

"COMPARISON convinced us that a SQUARE D Control Center offered us MORE!"

These design features make Square D your logical choice, too...

INCREASED SAFETY because bus bars are fully enclosed, rigidly supported and have ample cross section. Circuits are isolated by individually enclosed plug-in units. Disconnect handle designed for maximum operator protection.

FLEXIBILITY. Individual plug-in units or complete sections are easily added, removed or exchanged. Pushbuttons, pilot lights, and selector switches are readily added to unit doors.

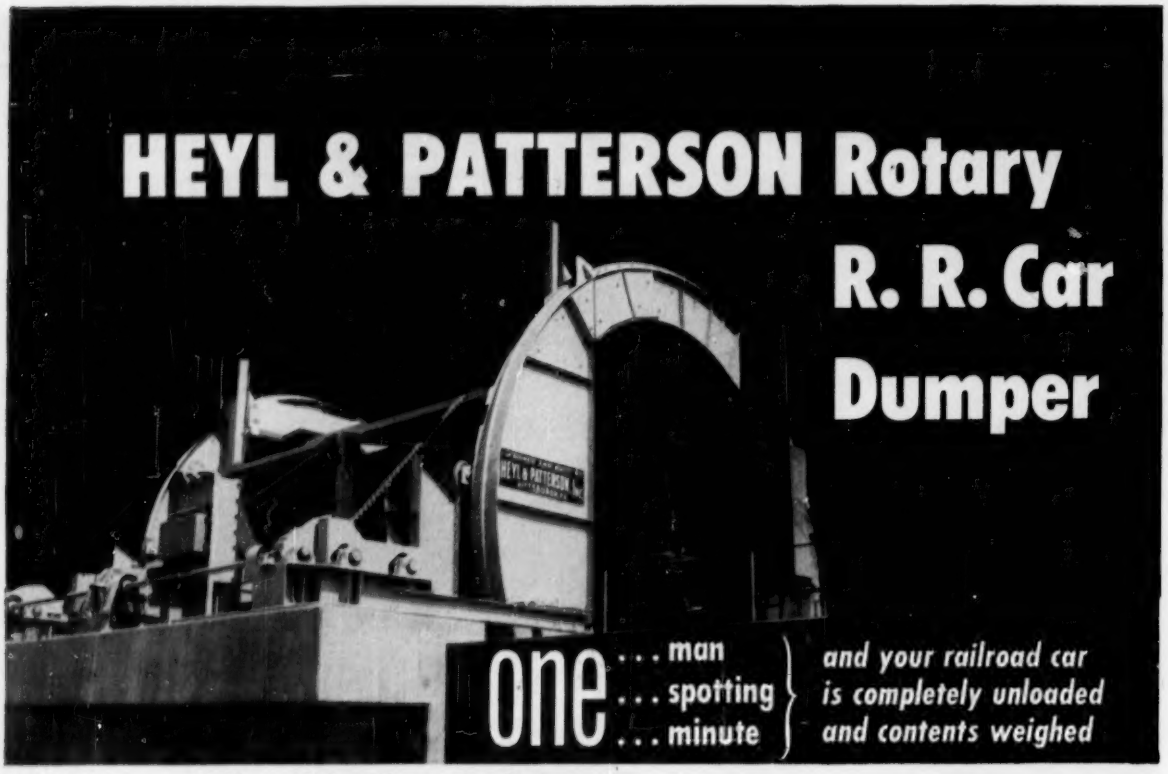
INSTALLATION ECONOMY. All wiring channels are large and accessible from front without removing units. No "wire fishing."

SPACE ECONOMY, TOO. Up to six combination starters fit in a 20" x 20" x 90" section. Plug-in unit heights designed in space-saving increments of 3 inches.

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

HEYL & PATTERSON Rotary R. R. Car Dumper



View of the Dumper at Buffington, Indiana Plant, Universal Atlas Cement Company.

- **Dumper is designed to rotate, dump and return to initial position in just one minute.**
- **Rotation can be stopped instantly at any position with car and platen firmly held in place.**
- **External and movable counterweights have been eliminated.**
- **Platen-mounted electronic scale is simple, accurate and economical.**
- **Car retarder on dumper permits economical and safe car spotting by dumper operator.**

To achieve the most economical car weighing and dumping operation, the H&P Rotary Car Dumper can be equipped with a car retarder or an electronic scale, or both. This H & P electronic scale platen (Patent Pending) uses load cells which permit instant weighing and light-weighing of car in compliance with National Bureau of Standards acceptance tolerance, and printing of weigh tickets. Exceptional accuracy and trouble-free operation are assured due to absence of wearing parts.

By all standards, the H & P Rotary Dumper is the most efficient method of unloading large quantities of bulk materials from open-top railroad cars.

Even if you receive only a relatively small number of cars per day, may we suggest that you investigate the economics of the H & P Rotary Railroad Car Dumper.

MAIL COUPON TODAY FOR NEW DUMPER BROCHURE 957

HEYL & PATTERSON, INC., 55 Fort Pitt Blvd., Pittsburgh 22, Pa.
Please send me my copy of the H & P Dumper Brochure 957.

Name_____ Title_____

Company_____

Address_____

City and State_____

70 YEARS OF SERVICE

Heyl & Patterson

AT WORK OR IN EMERGENCIES:

New type industrial fire hose jacketed with 100% DACRON offers you all these advantages

REG. U. S. PAT. OFF.

A LEADING SULFUR PRODUCER uses hose jacketed with 100% "Dacron" to fight fires both on company property and in the neighboring company town. This new hose works out exceptionally well in industries where exposure to sulfur and other degrading compounds is a problem.

- **LIGHTWEIGHT, COMPACT**
- **ABRASION-RESISTANT**
- **RESISTANT TO MANY CHEMICALS**
- **WEATHER- AND MILDEW-RESISTANT**

Now hose manufacturers make a fire hose that's ideal for general use around the plant. It's jacketed with 100% "Dacron"* polyester fiber and it offers unusual versatility because of the "just-right" balance of properties found in Du Pont "Dacron".

First, it's stronger hose (100% "Dacron" has more than 200 pounds greater test strength than most conventional single-jacket hose) and yet it's about 25% lighter. It is easier to handle, and much more flexible than previous types.

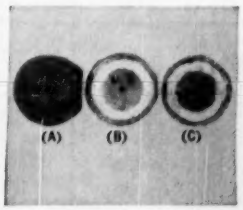
Hose jacketed with "Dacron" is economical to use for maintenance jobs because of its high abrasion resistance. It stands up under day-after-day exposure to most chemicals, too. Hose jacketed with "Dacron" has good resistance to acids, salt water, alcohols, oils, hydrocarbons and detergents. And this new type of hose *can't be weakened by mildew.*

Du Pont makes "Dacron" fiber, but does not manufacture hose. We'll be glad to send you the names of manufacturers of hose jacketed with 100% "Dacron". Write: E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Department, Wilmington 98, Delaware.

PROVED: Tests show how "DACRON" gives improved performance...

SOIL-BURIAL TEST.

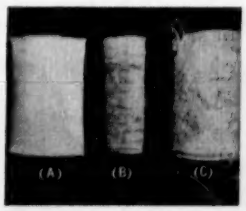
The two samples shown were buried in moist, warm soil for 28 days. When removed, the conventional hose specimen (right) showed signs of damage by bacterial and mold colonies. The specimen with jacket of 100% "Dacron" (left) did not support the growth of microorganisms and was merely soiled.



TABER ABRASION TEST.

In this test, hose specimens were compared for resistance to abrasion. Each test was stopped at the point where the hose had theoretically reached its maximum service life. (A "cycle" represents one complete revolution of the abrading wheel.)

(A) Rubber-covered conventional hose.....4,150 cycles
(B) Single-jacket hose of "DACRON".....12,500 cycles
(C) Conventional single-jacket hose.....1,830 cycles



CHEMICAL-RESISTANCE TEST.

Here's what happened when three common types of industrial fire hose were immersed in a 17% solution of sulfuric acid for 24 hours.

(A) 2½" hose, single jacket of "Dacron", no apparent damage.
(B) 1½" hose, conventional jacket, damaged.
(C) 2½" hose, "Dacron" and conventional fiber, no damage to "Dacron".

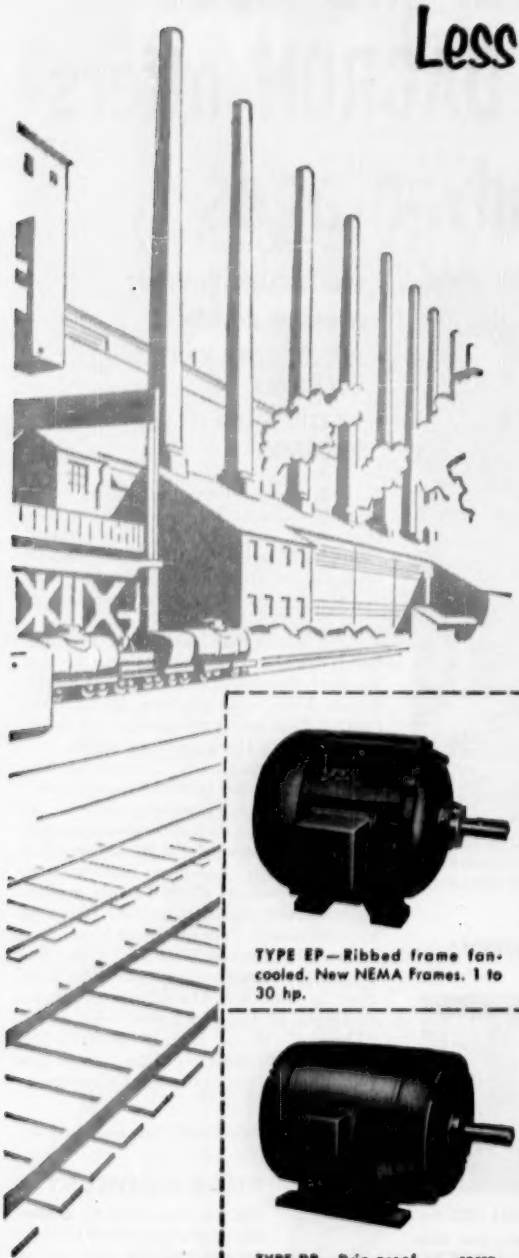
*"DACRON" IS DU PONT'S REGISTERED TRADEMARK FOR ITS POLYESTER FIBER.

FREE BOOKLET...

tells you more about the properties of hose made with "DACRON". For your copy write to: E. I. du Pont de Nemours & Co. (Inc.), 5520 Nemours Building, Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

FIRE HOSE MADE WITH "DACRON"—easier to handle . . . gives extra strength . . . not weakened by rot and mildew



Less down time...lower upkeep...

WITH

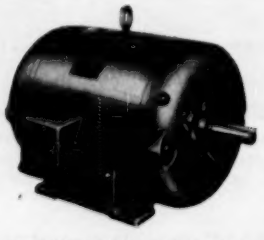
Wagner Protected Type Industrial Motors

Wagner protected type motors lower your maintenance costs . . . cut down time, because they are designed for use where operating conditions demand EXTRA protection—for bearings or windings, against corrosive vapors or abrasive dirt, in explosive atmospheres or exposed outdoor locations.

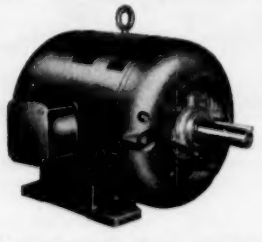
Each of these Wagner Motors will give completely dependable performance in its specific application—with a minimum of maintenance. All these motors can be relubricated, when necessary, for longer bearing life.

A Wagner field engineer, expert on motor applications, will be glad to help you choose the *right* motors for your specialized needs. Just call the nearest of our 32 branch offices, or write us for Bulletins on Wagner Industrial Motors.

TYPE EP—Ribbed frame fan-cooled. New NEMA Frames. 1 to 30 hp.



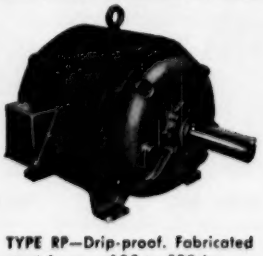
TYPE EP—Totally-enclosed fan-cooled. Corrosion-resistant frames. 40 to 250 hp.



TYPE JP—Fan-cooled . . . Explosion-proof. Cast iron frames. 40 to 250 hp.

TYPE DP—Drip-proof . . . corrosion-resistant. New NEMA Frames. 1 to 30 hp.

TYPE DP—Drip-proof. Cast iron frames. 40 to 125 hp.



TYPE RP—Drip-proof. Fabricated steel frames. 125 to 500 hp.

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

M57-8

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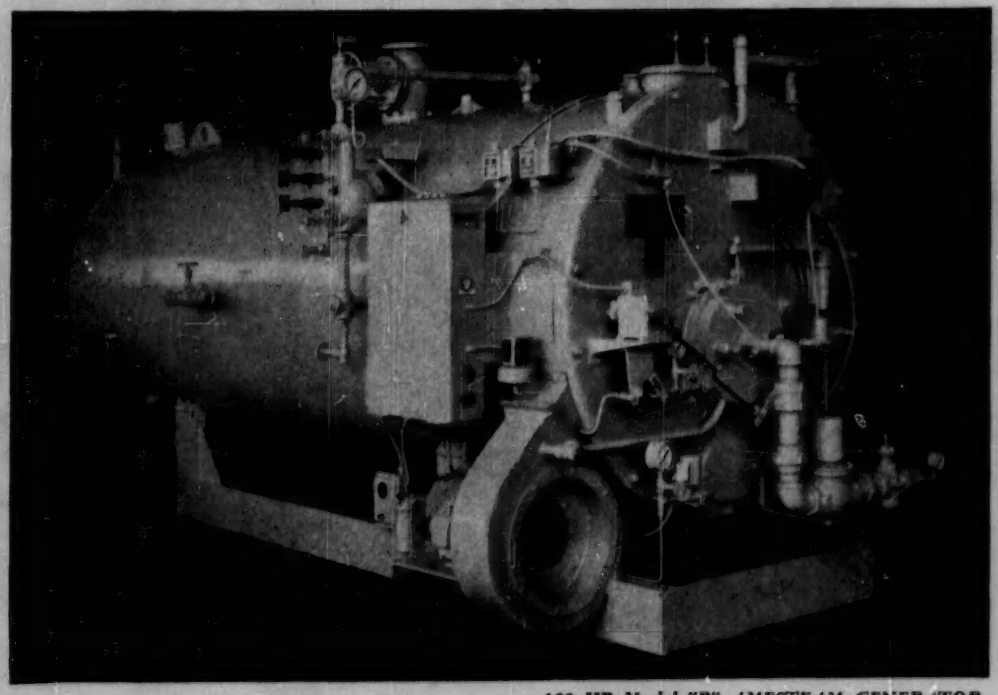
Wagner Electric Corporation
6401 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

NEW AMESTEAM GENERATOR

MODEL "R"



100 HP Model "R" AMESTEAM GENERATOR

We Kept Our PROVEN DESIGN
We Added "ENGINEERED SIMPLICITY"

Retaining all the time-proven principles and benefits so much in demand in AMESTEAM GENERATORS, the new Model "R" brings you many important improvements.

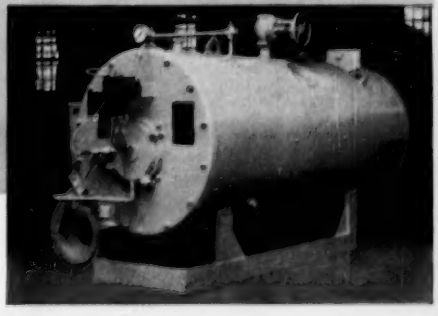
For example, the proven design of the Ames Pressure Vessel is preserved . . . but improved. You'll still find all its reliability, efficiency and simplicity. But, in the Model "R" you'll enjoy these advantages in a much more compact "package" . . . and at a price that will please you.

The Model "R" AMESTEAM GENERATOR is now available in sizes from 10 to 150 HP for pressures up to 250 PSIG, for oil, gas or combination oil-gas firing equipment. Quick fuel switchover is also available. Centrally-positioned auxiliaries and controls simplify your operating procedures.

Like all AMESTEAM GENERATORS, the Model "R" is shipped to you in firing condition, completely inspected and equipped to comply with the local, state or insurance codes specified. All you need to do is connect it up and put it to work.

Investigate the many extra bonus features awaiting you in the new Model "R". Write us today for new Model "R" Bulletin and name of your nearby AMESTEAM representative.

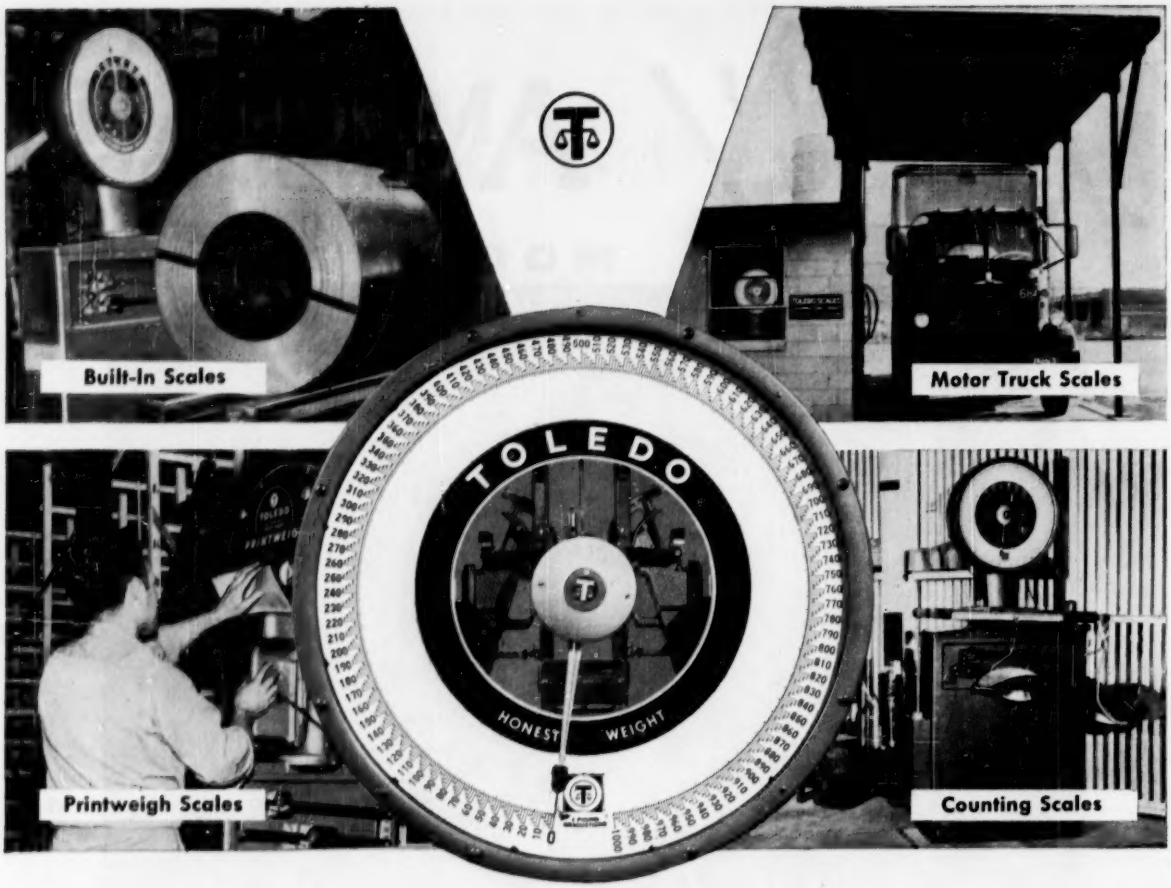
- **SURPRISINGLY COMPACT** — Saves Floor and Operating Space
- **GUARANTEED 80% EFFICIENCY**
- **CENTRALIZED CONTROLS** — Save Operating Time
- **NEW FLEXIBILITY OF INSTALLATION**
- **NEW EASE OF MAINTENANCE** — Conserves Manpower



50 HP Model "R" AMESTEAM GENERATOR

AMES IRON WORKS, INC.

BOX S-127 • OSWEGO, N. Y.



For new ways to control your costs . . .

take a *Plant-Wide Look* at Weighing!

What's the status of weighing in *your* plant? It's important to know because weighing is a vital element in the overall cost control system. Weight records directly affect costs, quality, inventory control and customer billing. Weighing errors—or inadequate weight data—set the stage for losses in output, profits and customer good-will.

This calls for integration of weighing in a plant-wide weighing system . . . the right scales in the right places . . . to supply basic records on materials received, processed, shipped or transferred.

To learn the job your scales are now doing, we invite you to send for the new Toledo Weight Fact Kit. It will help you determine how well your scales measure up as a weighing system—help you detect weighing inefficiencies that drain profits.

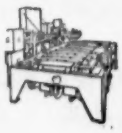
REQUEST YOUR WEIGHT FACT KIT NOW. No obligation. Address Toledo Scale Company, 1403 Telegraph Road, Toledo 13, Ohio.

TOLEDO® HEADQUARTERS FOR WEIGHING SYSTEMS

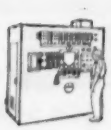
CUSTOM PRODUCTS FOR INDUSTRY

REMOTE DIGITAL WEIGHTS. Toledos automatically transmit weights to electric office machines located anywhere.

ELECTRONIC SCALES give electronic wings to weights; head may be located anywhere.

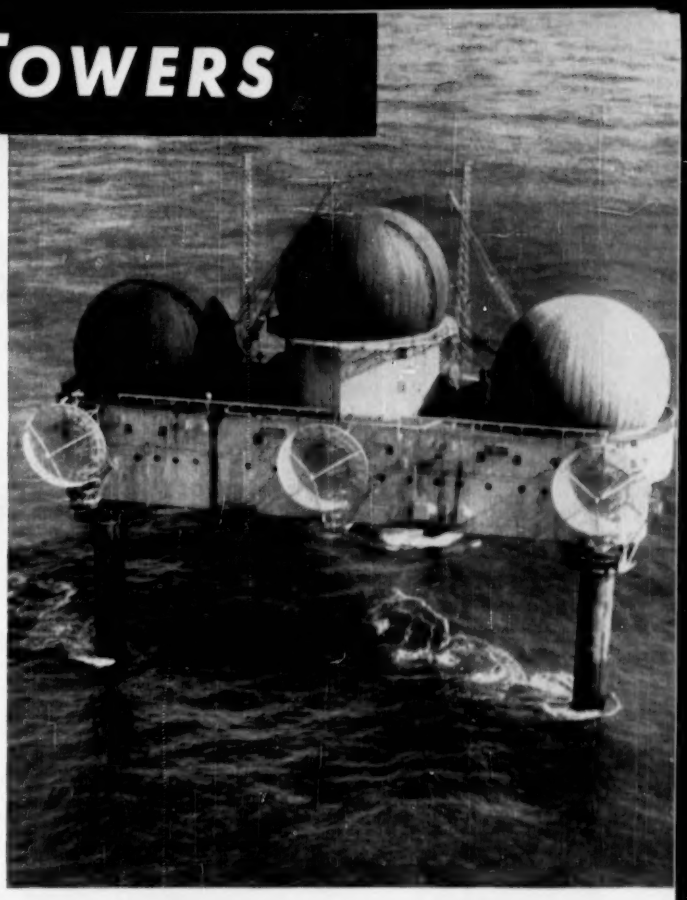


TESTING Toledos today test a wide range of parts; this device for leaf springs.



AUTOMATIC BATCHING SYSTEMS interlock batteries of scales.

ON TEXAS TOWERS



Wallace Process Piping Co., Inc.

Used

MIDWEST

WELDING FITTINGS

Among the unique installations for preservation of peace are the early warning radar "Texas Towers" off the Atlantic Coast. These artificial islands stilted to the ocean floor keep watch by radar. As is true of many defense projects, Midwest Welding Fittings played a significant part on Texas Towers.

Midwest Welding Fittings are found on unusual and in critical as well as routine jobs because of exceptional quality maintained by rigid standards of manufacture. Quality control is always above and beyond code requirements.

Whatever the piping job, you will find it to your advantage to use Midwest Welding Fittings. The many benefits you get by specifying "Midwest" are shown in Catalog 54. Ask your distributor or write us for a copy.

MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Missouri (P.O. Box 433)

PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES

SALES OFFICES:

ASHEVILLE (BOX 446, SKYLAND, N. C.) • BOSTON 27—426 FIRST ST.
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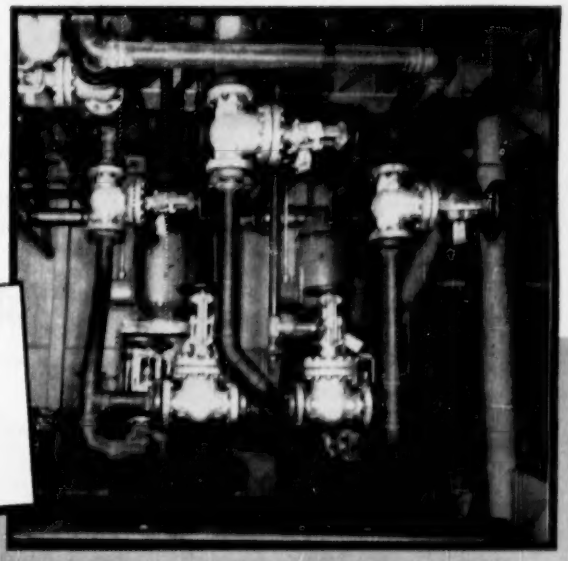
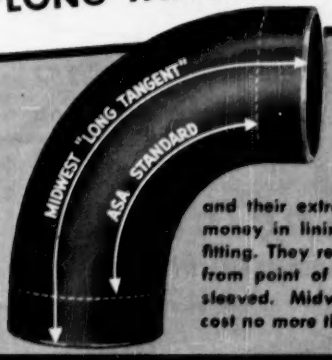
MIAMI 34—2103 LE JEUNE RD. • NEW YORK 7—50 CHURCH ST.
ONEIDA, N.Y.—282 NORTH MAIN ST. • PITTSBURGH 19, PA.—437 GRANT ST.
ST. LOUIS 4—1450 S. SECOND ST. • SAN FRANCISCO 11—420 MARKET ST.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES



MONEY SAVED With MIDWEST "LONG TANGENT" ELBOWS



Here are the important advantages of Midwest "Long Tangents": They save pipe. They often eliminate short nipples and their extra welds. They save time and money in lining up and clamping pipe and fitting. They remove the circumferential weld from point of maximum stress and can be sleeved. Midwest "Long Tangent" Elbows cost no more than other elbows.

Piping on two Texas Towers was installed by Wallace Process Piping Co., Inc., as subcontractors to Steers Morrison Knudsen and Continental Copper & Steel Industries, Inc. All welding fittings were supplied by Midwest through Central Jersey Supply Co. The many advantages of Midwest "Long Tangent" Elbows were an important factor in the selection of Midwest fittings for this critical work.

7901

MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

NEW BULLETIN on Laboratory and Pilot Plant HIGH PRESSURE REACTORS

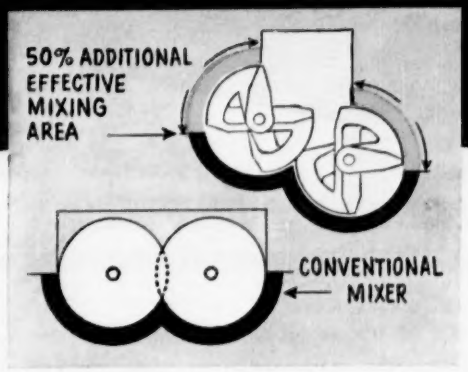
BULLETIN 357
Laboratory • Pilot Plant
HIGH PRESSURE EQUIPMENT
AUTOCLAVE ENGINEERS
REACTORS 1957
Laboratory and Pilot-Plant Sizes
For Laboratory and Pilot Plant . . .
HIGH PRESSURE REACTORS
Up To 100,000 p.s.i.
To meet the demands for modern research tools, Autoclave Engineers presents this convenient source of information on laboratory and pilot plant reactors. Details and specifications on an extensive range of reactors of both standard and special design are contained in the following pages.
Obviously, it would be impractical to illustrate and detail in this bulletin all of the many reactors which have been designed and built by Autoclave Engineers for specific research projects. However, the following pages do give an overall picture of the capabilities which you can utilize by consulting with us on your own specific requirements.
APPLICATIONS: Batch Reactions Flow Systems
USES:
Reaction Vessels
Accumulators
Storage Vessels
Compression Cylinders
Utility Vessels:
Dryers
Scrubbers
Contactors
Packed Columns
MICRO REACTOR
1 LITER REACTOR IN STAND
2½ LITER REACTOR • CONFINED GASKET CLOSURE

This new Bulletin 357 is yours for the asking—

Autoclave Engineers

2932 WEST 22nd STREET • ERIE, PENNSYLVANIA

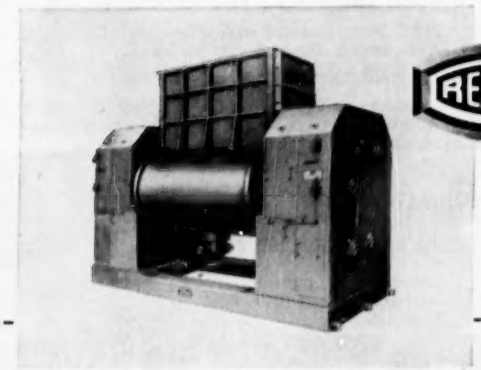
take this unique design... PRESTO! a much faster mix!



with Readco's unique split-level bowl: complete dispersion, shorter cycle, lower cost

The special design of this Readco mixing bowl provides a 50% greater effective mixing area. Overlapping sigma arms operate at minimum clearance from the shell, prevent build-up of materials, speed dispersion. The design also permits maximum heat transfer from the jacket.

You'll get complete dispersion, consistent mixing, in substantially shorter cycles. Working capacities range from 150 to 900 gallons. Write for complete information.



READCO

Whatever the mixing job: a READCO mixer!

READ STANDARD

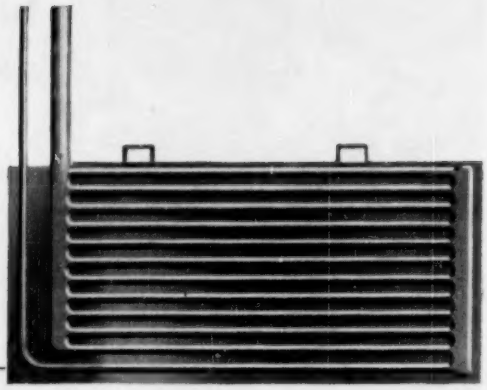
York, Pennsylvania

A Division of Capitol Products Corporation

See this mixer featured in our exhibit of processing equipment at the New York Chemical Exposition, December 2-6, Booth 162

PLATECOIL®

The answer to your special heat transfer problems



SAVES ON ENGINEERING, FABRICATING

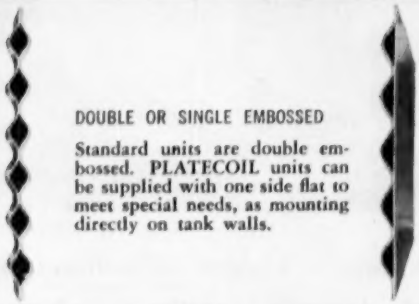
INSTALLATION, OPERATION AND MAINTENANCE COSTS

A Tranter PLATECOIL consists of two embossed metal sheets, seam and spotwelded together to form channels for the passage of heating or cooling media. Compact, lightweight PLATECOIL units are furnished in a wide range of standard sizes and styles.

PLATECOIL saves space, requiring about half the space of a pipe coil of equivalent heat transfer area. Heat transfer is accomplished fully 50% faster by PLATECOIL as compared to pipe coils.

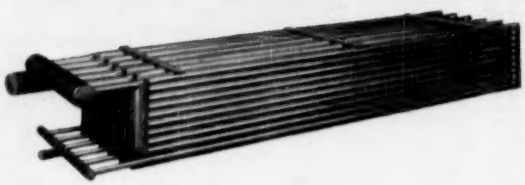
PLATECOIL Units are available in Cold Rolled Steel, Stainless Steel, Carpenter 20, Monel, and other corrosion-resistant alloys. In addition to the many sizes and styles available as standard PLATECOIL units, special units can be built on order to fit your specific requirements.

STANDARD OR SPECIAL FACTORY FABRICATED UNITS TO FIT YOUR NEEDS



DOUBLE OR SINGLE EMBOSSED

Standard units are double embossed. PLATECOIL units can be supplied with one side flat to meet special needs, as mounting directly on tank walls.



BANKED

Factory-fabricated banks of PLATECOIL are available for specific applications in heating or cooling.

ROLLED

PLATECOIL Units may be rolled to a specified diameter in the direction of width or length, in either single embossed or standard units.

WITH SURFACE FINISHES

PLATECOIL can be galvanized, metallized, electropolished, polished for food service; prepared for plate finishes, lead and thermo-plastic coatings.

STRUCTURAL PARTS

PLATECOIL can be incorporated into heated or cooled conveyors, tank walls, baffles or partitions.

SPECIAL CONNECTIONS

Pipe connections can be supplied longer or shorter than standard, at right angles, in couplings, pipe nipples or elbows; in various positions.

COMPLETE APPLICATION INFORMATION
WRITE FOR FREE
TECHNICAL DATA MANUAL P61

Tranter Manufacturing Inc.

LANSING 9, MICHIGAN

PLATECOIL® DIVISION

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U.S.I. CHEMICAL NEWS

★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★

U.S.I. Joins Mallory And Sharon in Integrated Company to Produce Zr, Ti

U.S.I. will soon join in the management of Mallory-Sharon Titanium Corporation which will change its name to Mallory-Sharon Metals Corporation. The reorganized company will then produce zirconium and titanium metals and mill products, and other special light metals such as hafnium. Each of the following companies owns a one-third interest in the new enterprise: National Distillers and Chemical Corporation (U.S.I. Division), P. R. Mallory & Co., Inc. and Sharon Steel Corporation.

All assets of both the Mallory-Sharon Titanium Corporation and Reactive Metals, Inc., as well as USI-National Distillers' zirconium plant and forthcoming titanium plant will be combined in the newly formed corporation. With assets exceeding $55 million, the new company will be the largest fully integrated producer of special metals.

Presidents of the three owner companies have made this joint statement: "This consolidation of interests creates a completely integrated special metals company with technical 'know-how' and facilities for every step, from original chemical process to production and fabrication of finished products. The benefits from this strengthening of operations, plus the combination of current and future research activities, hold great promise for present production of titanium and zirconium and for other special metals as well."

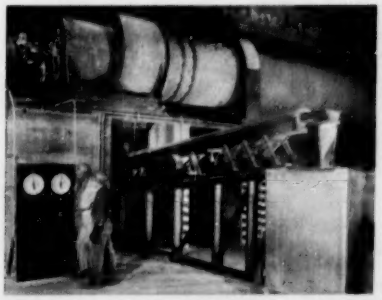
Zirconium Metal Plant Starting Up

In 1956 U.S.I.-National Distillers was awarded a contract by the Atomic Energy Commission to supply one million pounds of zirconium metal annually for a five-year period. A plant was designed and built at Ashtabula, Ohio with a design capacity of 2 million pounds per year, and the plant is now in process of being started up. Hafnium sponge and oxide will also be produced as an adjunct to the zirconium operation.

A titanium sponge plant with a design capacity of ten million pounds per year is under construction at Ashtabula.

Both of these plants have been designed to utilize a new sodium-reduction process developed by U.S.I.-National Distillers. It is

MORE



Zirconium oxide kiln in chemical processing section of Mallory-Sharon Metals Zr plant.

Methionine Given After Exposure Reduces Damage From Radiation

Report Is First Evidence of Methionine's Effectiveness Against Tissue Breakdown When Given After Exposure to Radiation

New experimental evidence indicates that the sulfur amino acid, methionine, is even more effective in reducing tissue damage caused by radiation when administered *after* radiation exposure than it is when given *before* exposure.

Earlier reports have demonstrated methionine's ability to protect experimental animals from the effects of subsequent exposure to X-ray irradiation (U.S.I. CHEMICAL NEWS, Sept.-Oct., 1955). The present work, reported in a leading English scientific journal by Indian scientists working in Bombay, is believed to be the first to show methionine's post-irradiation effectiveness.

In the tests, deoxyribonucleic acid (DNA) levels in the liver, spleen and bone marrow were used as a measure of the extent of radiation damage. DNA is the substance in the nucleus of all cells believed to carry the mechanism of heredity. The researchers found that DNA levels in untreated animals were reduced by as much as 87% after exposure to radiation. DNA in methionine-treated animals was reduced to only about one-half of pre-exposure levels.

Methionine administered prior to irradiation afforded a considerable amount of protection, but was less effective than post-irradiation treatment. The radiolability of methionine—its tendency to be destroyed by ionizing radiations such as X-rays—is believed to account for this reduced effectiveness.

In evaluating the pre- and post-irradiation effectiveness of methionine, however, it should be noted that in the recent work methionine was given intraperitoneally. It has been reported (U.S.I. CHEMICAL NEWS, July, 1957) that radiation can cause a decrease in the ability of the body to absorb methionine that has been fed orally.

Methionine Aids Nucleic Acid Synthesis

The specific means by which methionine acts to prevent tissue damage from radiation is related to the nucleic acid synthesizing mechanism itself. Methionine is known to play a part in two chemical processes which are involved in the production of DNA — transmethylation and phosphorylation. (Methionine is a principal source of methyl groups for the animal organism and is a precursor of creatine, which is active in the phosphorylation process.) Thus, by aiding two of the essential routes by which nucleic acids are made, methionine keeps the synthesizing mechanism in order and exerts a therapeutic influence on radiation injury.

The considerable amount of research that has been done on methionine's effectiveness in minimizing radiation damage stems from methionine's well known ability to promote healing of wounds and burns. It is also a detoxifying agent through its action on the liver.

MORE

Brightness Is Controlled By pH in Sodium Peroxide Bleaching of Groundwood

A recently reported investigation into the fundamental chemistry of bleaching groundwood with sodium peroxide indicates that reaction rate and pulp brightness increase with pH. However above a certain pH, a colored compound is formed which tends to yellow the pulp. Therefore there is, in commercial practice, an upper pH limit for the production of pulp having maximum brightness.

Brightness Development in Sodium Peroxide Bleaching of Groundwood

pH	Time to reach max. brightness, min.	Effective H_2O_2 consumption, g/l.	Maximum brightness, %
9.0	180	0.10	57.1
10.0	130	0.33	59.3
10.5	110	0.47	60.2
11.0	80	0.53	60.7
11.5	70	0.53	60.2
12.0	40	0.56	60.4
12.5	20	0.48	59.2

Sodium peroxide bleaching of groundwood has been used for some time by pulp makers. It produces a relatively large increase in brightness at low cost, without affecting pulp quality adversely or decreasing yield materially.

This study reveals that the rate of total peroxide consumption increases as pH rises from 9 to 12, due largely to the increased rate of the peroxide-groundwood reaction. The rate at which peroxide decomposes to form oxygen also goes up with pH, but this is minimized by materials in the groundwood and by adding stabilizers.

It was also learned that the rate and amount of brightness improvement increases with pH. Yellow color, mentioned previously, increases at the same time, the effect being more pronounced toward the end of the bleaching period. It causes reversion of brightness in some cases.

The most effective bleaching under the conditions used by the investigators was obtained at pH 11. Here the peroxide-groundwood reaction is fast enough, in relation to the decomposition reaction, to give appreciable bleaching in the first third of the bleaching period. On the other hand, the pH level is not high enough to produce excessive color shift and brightness reversion.

Sodium peroxide for groundwood bleaching is made from metallic sodium at U.S.I.'s plant in Ashtabula, Ohio.

U.S.I. CHEMICAL NEWS

CONTINUED Methionine

Methionine also is known to improve feathering in poultry and hair coat quality in fur bearing animals. As the only sulfur-containing essential amino acid, it is widely used in the manufactured feed industry as a protein supplement to promote growth and health in livestock and poultry.

The first commercial synthesis of methionine, which has led to its widespread use in medical and animal feed applications, was pioneered by U.S.I.

CONTINUED New Company

believed to be the lowest cost method developed to date for the production of these metals. Mallory-Sharon Metals will be granted an exclusive, royalty-free license in the U. S. for the production of titanium, zirconium and other metals by this process.

Sodium is supplied by the existing U.S.I.-National Distillers sodium operation three-quarters of a mile away. At Ashtabula, Mallory-Sharon Metals will also have facilities for melting zirconium metal into ingots.

Titanium sponge will be melted and both metals fabricated at the existing Mallory-Sharon plant at Niles, Ohio.

High Purity Silicon Being Made Via Sodium Reduction

High purity metallic silicon for electronics use in semi-conductor devices is now being produced by the sodium reduction of silicon tetrachloride. The product contains boron in the order of two parts per billion, and has resistivities up to 500 ohm-centimeters.

Several thousand pounds of the material have already been manufactured in one plant overseas, and indications are that this process is more economical than either hydrogen reduction of silicon tetrachloride or reduction of silicon monoxide.

New Cooling Towers Packed with Polyethylene Grids

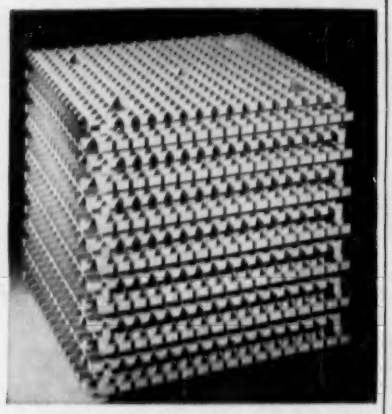


Photo shows typical stacking arrangement of polyethylene grids. (courtesy Fluor Products)

Polyethylene is now being injection molded into grid packings for water cooling towers. These grids are designed to provide the air-water contact surface usually provided by wooden bars or slats. They cool very efficiently, and eliminate maintenance problems due to their strength and corrosion resistance.

The grids are available in 2 sizes (3 ft. sq. and 2 ft. by 4 ft.). They are stacked vertically two inches apart in the cooling tower. This spacing arrangement allows for horizontal distribution of rising air and cascading water. It provides the same cooling efficiency as would the usual unspaced series of wooden slats while saving weight and material.

In addition to applications in new industrial and air conditioning cooling towers, these polyethylene grids can replace worn out portions of wooden packings in existing cooling towers. They have potential in gas scrubbers, trickling filters and other operations where efficient gas-liquid contact is desired.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U. S. I.

Polyethylene packaging materials are illustrated in a recent brochure. Bags, sheets, drum-liners and pressure-sensitive tapes are described, as well as water vaporproof, flexible and protective wraps made of barrier material. **No. 1291**

Buffer salts in disposable packets are now available. Each packet is carefully weighed, has been lot-analyzed for purity. Contents dissolved in a litter of water provide a ready-to-use buffer solution. **No. 1292**

Tape entry to computers is facilitated by a new machine with internal core storage, which gathers asynchronous digital information from external sources and combines them in any sequence with record numbers and manually inserted data. **No. 1293**

A new pamphlet on zirconia discusses the history, the chemical and physical properties, the composition, and the porosity of the chemical. Included is a refractory comparison chart. **No. 1294**

A calibrated dispenser delivers a specific volume of liquid from 1 cc. to 100 cc. rapidly and repeatedly. Measurement is automatic, said to be accurate to within 1%. Can be used for volatile, toxic, or alkaline liquids. **No. 1295**

Two monomeric ester-type plasticizers are said to be useful for safety glass, synthetic rubbers and lacquers, and as plasticizers for cellulose acetate butyrate, polystyrene, acrylic resins and ethyl cellulose. **No. 1296**

A pamphlet on fire research reports of the facilities, personnel and management of the principal agencies engaged in this work. It also describes tests of various materials and fire-protection systems. **No. 1297**

A polyethylene pump is now being made for use with inflatable boats and mattresses. Air is trapped inside the bag by folding the top together, and forced into the mattress through a valve by compressing the bag. **No. 1298**

Oleoresin mace, a new spice oleoresin, is described as a dark, reddish-brown, homogeneous liquid, and is said to be completely solvent-free. It contains from 50 to 60 cc. of volatile oil per 100 grams net. **No. 1299**

A new nickel stripper is reported to contain no cyanide, caustic or acid, and to be stable over long periods of time, even at high temperatures. Manufacturer claims it will not fume, pit or corrode. **No. 1300**

PRODUCTS OF U.S.I.

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Intermediates and Fine Chemicals: Acetoacetarylides, Dimethyl Hydrazine, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Chloride, Ethyl Sodium Oxalacetate, U.S.I. ISOSEBACIC® Acid, Methyl Hydrazine, Sodium Ethylate Solution, Triethyl Aluminum, Trimethyl Aluminum, Urethan USP (Ethyl Carbamate).

Animal Feed Products: Calcium Pantothenate, Choline Chloride Products, MOREA® Premix, Special Liquid Curbay®, DL-Methionine, Niacin USP, Riboflavin Concentrates, Vitamin B_{12} and Antibiotic Feed Supplements, Vacatone® 40, Vitamin D_3 and K_3 Products, Antioxidant (BHT) Products, Special Mixes, U.S.I. Permadry Products (Sealed-In Vitamin A).

Inorganic Chemicals: Ammonia, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sulfuric Acid.

Metals: Titanium Sponge, Zirconium Sponge, Zirconium Platelets, Hafnium Oxide, Hafnium Sponge.

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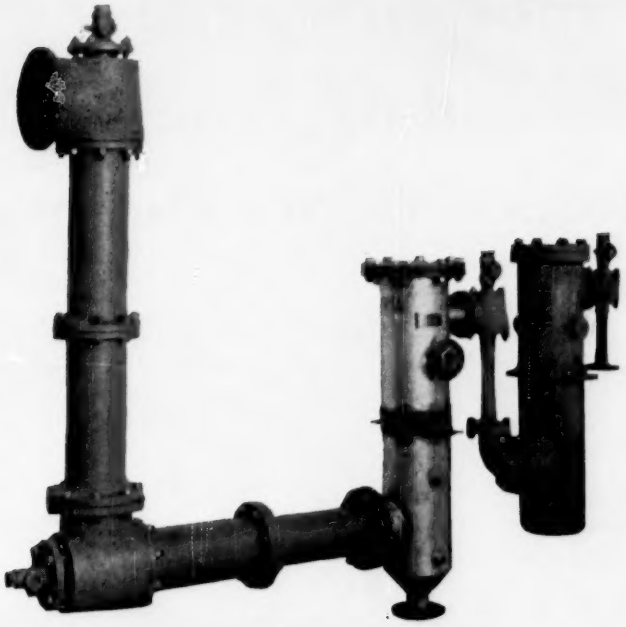


JET-VAC EJECTORS— pioneering new ways to handle corrosive fluids!

Efficient, low cost Jet-Vac ejectors are being used increasingly in the process industries to solve previously "unsolvable" corrosive fluid handling problems. Here's how — and why:

1) Thanks to years of pioneering research in engineering and advanced metal working techniques, Jet-Vac ejectors can be made with super alloys and many other special corrosion-resistant materials which give a new measure of protection in handling corrosive fluids.

2) Jet-Vac (and *only* Jet-Vac) makes corrosion resistant parts *interchangeable* with standard parts. This permits extra flexibility in material selection, and added economy as well — since parts can be replaced or substituted with no piping changes.

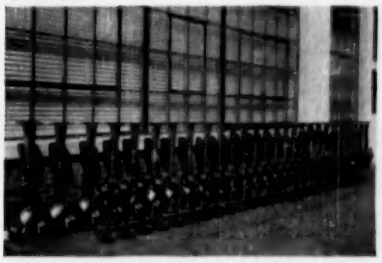
Whatever your ejector problems, you can put this pioneering know-how to work for you with absolute confidence. FREE — Fact-packed folder gives full information on our many services. WRITE TODAY!

Here is a handy conversion unit table for ready reference	JET-VAC EQUIPMENT	MATERIALS
1" Hg = 0.49 psi *1 gpm water = 500 lb./hr.* *1 psi = 2.31' water* *1 standard cfm air = 4½ lb./hr.* *1 ton refrigeration = 12,000 BTU/hr.* *A critical flow nozzle of 1 sq. in. area will pass:* *(a) 6000 lb./hr. of 100 psig dry and saturated steam* *(b) 1200 lb./hr. of standard air* *(Flow is proportional to absolute pressure and to area)*	*Steam Jet Vacuum Ejectors • Steam Jet Thermo-Syphons • Hydro Jet Ejectors • Thermo Compressors • Special Process Jets • Mixing Jets • Draft Inducers • Vacuum Refrigeration*	*Stainless Steel • Hastelloy • Illium • A 286 • Haveg • Teflon • Rubber-Lined Steel • Carbon • Cast Iron • Bronze • Ni-Resist • Monel • Titanimum*

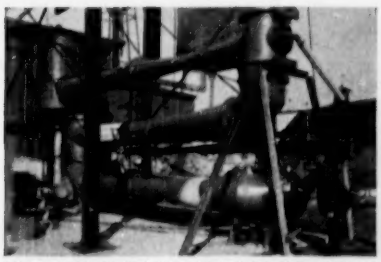
JET-VAC

THE JET-VAC CORPORATION, *400 Border Street, East Boston, Mass.*

Large steam jet boosters for chemical processing. Stainless steel construction affords better internal and external corrosion resistance lighter weight.



Stainless steel thermo-syphons, used in ordnance plant to heat a corrosive liquid to its boiling point and keep it circulating.



These are booster jets for 5-stage system built to furnish motive power for a high vacuum supersonic wind tunnel.

JET-VAC *one of a family of companies with an integrated service for manufacture of process equipment.*

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KONTRO

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*40° ROLL-BACK AT GROUND LEVEL

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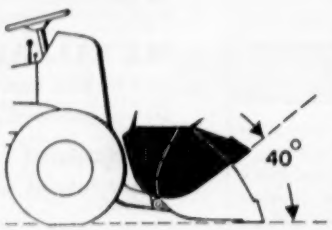

Magee Co-op, a chemical fertilizer manufacturer at Magee, Miss. have been using "PAYLOADER" tractor-shovels for fifteen years to unload rail cars of raw materials and to move fertilizer for bagging and unloading operations. They recently added a new-style model HA "PAYLOADER" to their fleet, and Mr. O. M. Ainsworth, the Plant Superintendent is pleased with its performance as he reports:

"We have been using Houghs for about 15 years and the success we have experienced with them was our reason for buying the new-style model HA 'PAYLOADER'. It has increased production load delivery, matching older, larger tractor-shovel on the same job. New design roll-back bucket action has cut rail car unloading time, keeps floors cleaner, moves more material."

Chemical and fertilizer plants of all kinds and sizes report the same kind of superior performance from their new-style "PAYLOADER" tractor-shovels—the greater digging power and carrying capacity of the roll-back bucket action, the reduction of spillage loss with the hydraulic load shock-absorber, lower maintenance and easier operation. It will pay you, too, to find out what a modern "PAYLOADER" can do to increase production and reduce the costs of handling loose, bulk materials. Your Hough Distributor is ready to demonstrate. Also ask him about Hough Purchase and Lease Plans.

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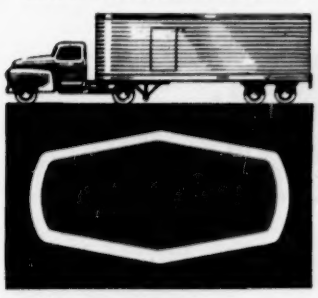

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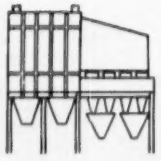

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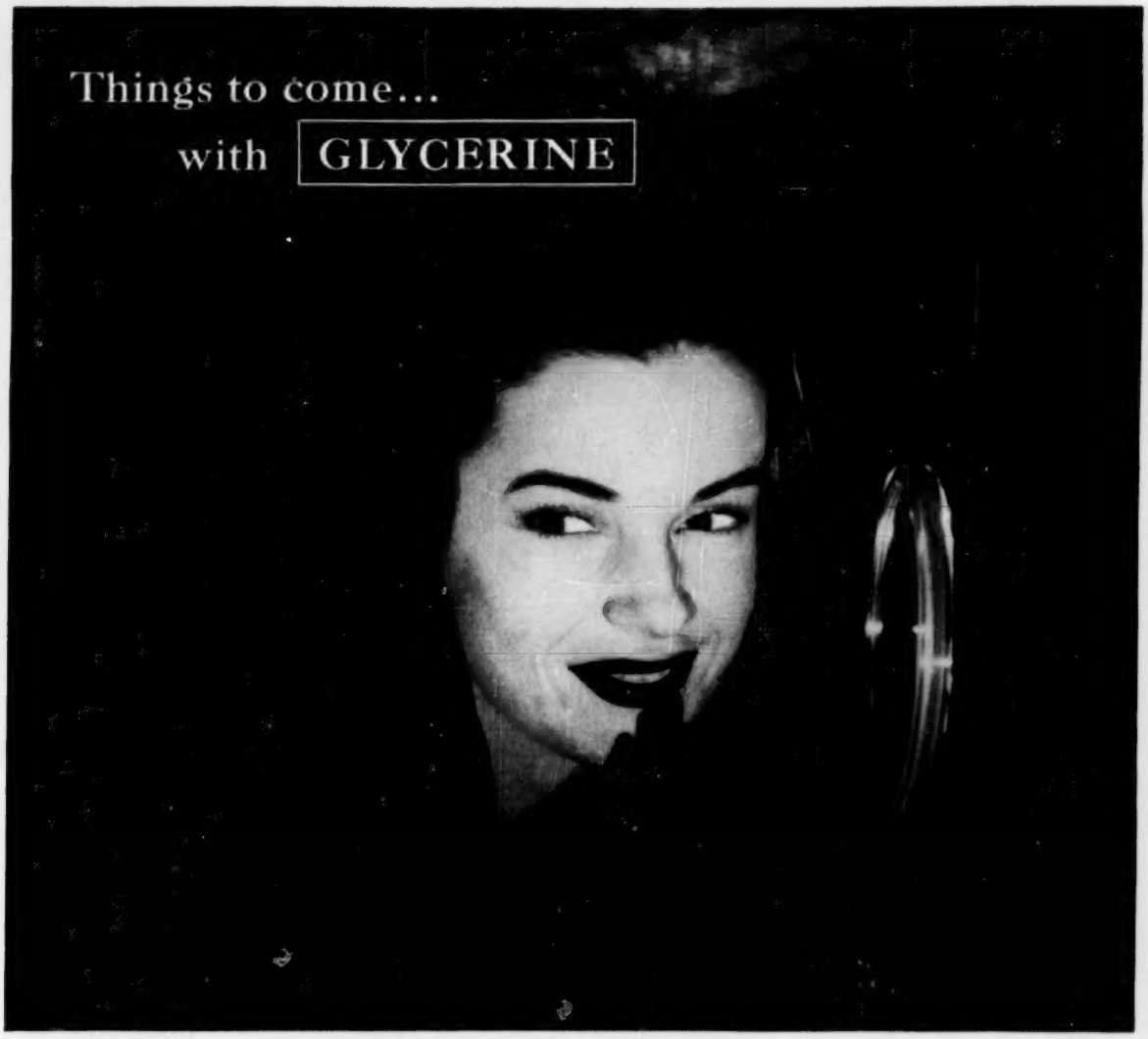

Nice work for a new derivative

Among the newest of Glycerine's derivatives to enter beauty's service are the acetoglycerides. The acetoglycerides promise to produce cosmetics that are easy to apply and which retain initial plasticity under widely varying conditions.

New chemicals such as the acetoglycerides, based on the structure of Glycerine, and new formulations stemming from the physical properties of Glycerine itself, are among the reasons for the continuous expansion in the use of Glycerine by the cosmetics and toilet goods industry.

Glycerine is widely used in oil-in-water emulsions in vanishing type creams. Here it smooths application and prevents "rolling." Glycerine is also a needed plasticizer, solvent, and humectant in beauty packs, creams and deodorants. It is used in depilatories based on methyl cellulose. It is preferred in many skin toning and dry skin lotions, and is virtually indispensable in the aqueous phase of industrial protective creams.

Stable in price, dependable in supply, Glycerine offers processors a unique balance of properties: it is hygroscopic, nontoxic, stable, nonvolatile, with excellent solvent power and agreeable taste. For a useful 20-page booklet, "Glycerine Properties and Uses", write to:

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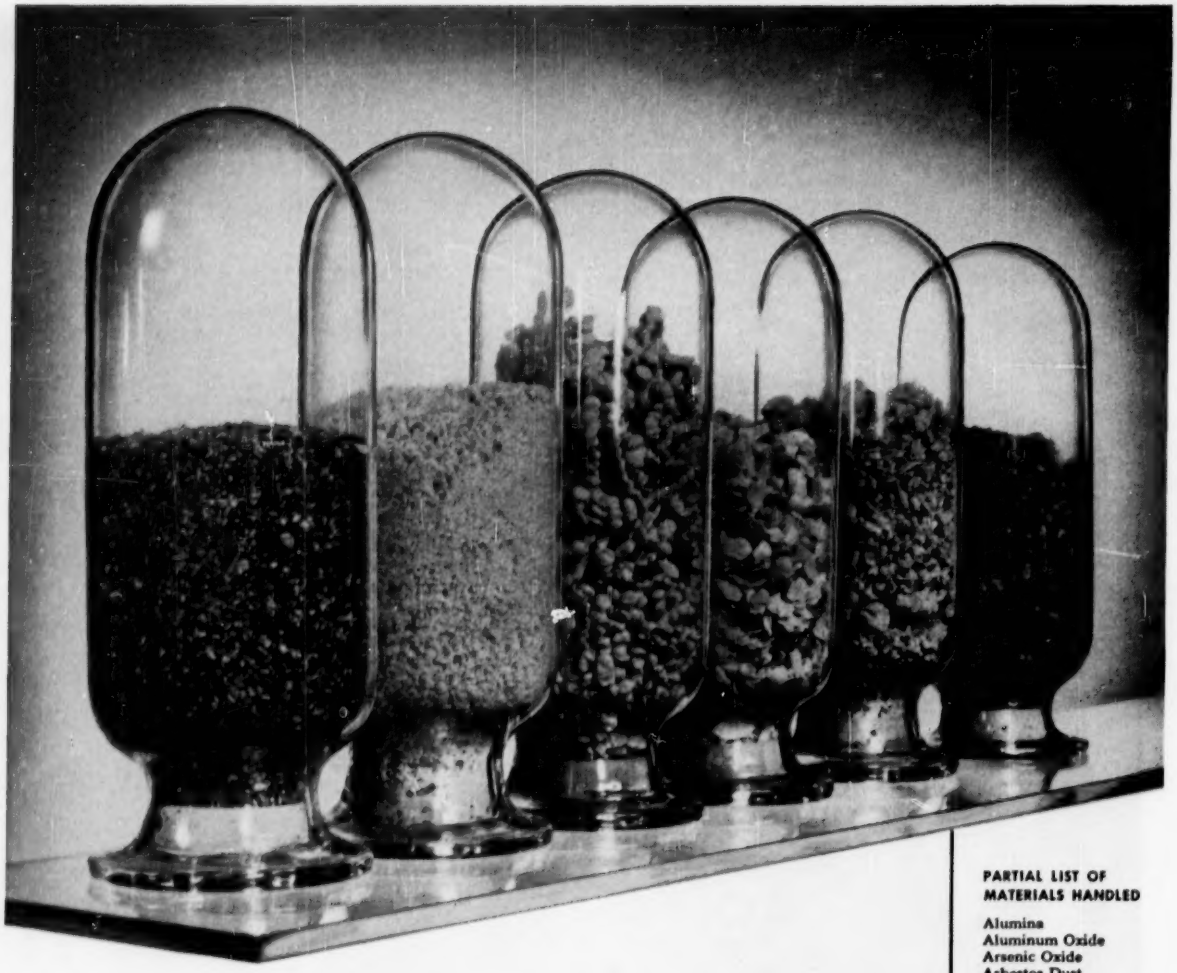

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Efficient, peak production is assured and at far lower operating costs than many other types of conveying systems, and your maintenance problems are at the minimum. Why not write to Fuller Company today—we'll be glad to send you descriptive literature showing you how Fuller solves many different problems in many types of plants.

PARTIAL LIST OF MATERIALS HANDLED

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Aluminum Oxide
Arsenic Oxide
Asbestos Dust
Barite
Bauxite
Bentonite
Borax
Calcium Carbonate
Carbon Black
Catalysts, Petroleum
Cement, Portland
Cement Raw Material
Chalk
Clays
Coal, pulverized
Detergent Powders
Diatomaceous Earth
Feeds, soft
Fertilizers
Flour
Flue Dusts
Fly Ash
Gypsum (raw or calcined)
Lime, pulverized
Malt
Ores, pulverized
Phosphate Rock, pulverized
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Sugars, refined
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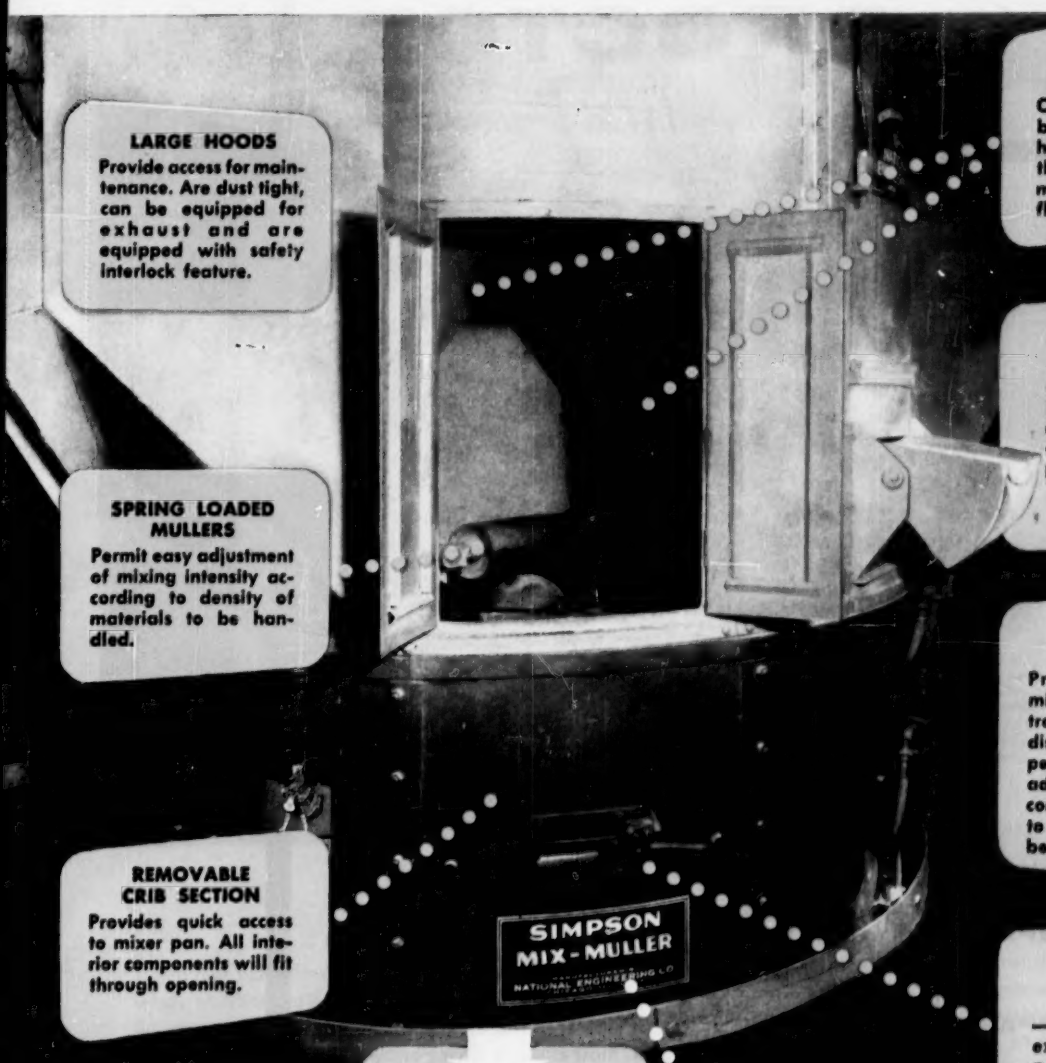
G-151
3756

Why Engineers prefer Simpson *MIX-MULLER*®



LARGE HOODS
Provide access for maintenance. Are dust tight, can be equipped for exhaust and are equipped with safety interlock feature.

SPRING LOADED MULLERS
Permit easy adjustment of mixing intensity according to density of materials to be handled.

REMOVABLE CRIB SECTION
Provides quick access to mixer pan. All interior components will fit through opening.

BOTTOM DISCHARGE
Plows clear pan quickly, thoroughly—*automatically* through bottom door. Discharge to belt, elevator, hopper screen, etc., is easily arranged.

HOOD CAN ENCLOSE HOPPERS
Components of mix can be held ready in batch hoppers. You get the *quality* of a batch mix, on a continuous-flow basis.

ADDITIONS HOPPER
Can be air or mechanically operated. Can be located anywhere on periphery of hood.

TIME MASTER® CONTROLS
Provide push button mixing operation. Control of mixer charge, discharge, batch hoppers, water and other additions as well as control of material flow to and from mixer, can be automatic.

MATERIAL SAMPLER
—is safe, positive and externally mounted at position of users choice.

THE SERVICES OF NATIONAL

. . . Engineering Company stand behind every Simpson Mix-Muller produced. By taking advantage of these services you get the benefit of 40 years of practical experience in the integration of mixing equipment. Complete design and engineering facilities for materials handling equipment, raw materials storage, etc., are included in the National service. This single responsibility through design, manufacture and installation will assure you of top mixing performance . . . from a properly integrated mixing plant.

Write for the new bulletin on mulling.

C576

SIMPSON MIX-MULLER® DIVISION

National Engineering Company
636 Machinery Hall Building • Chicago, Illinois

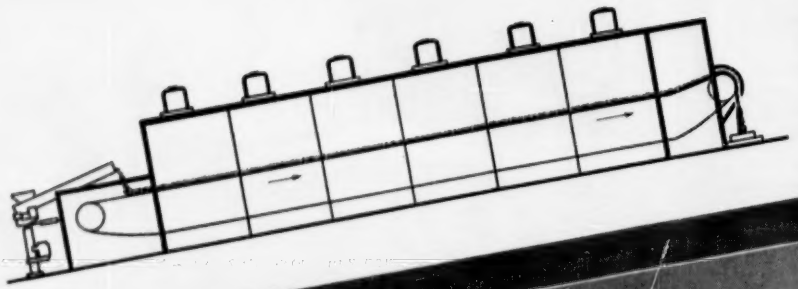
another

PROCTOR

first!

Proctor proudly presents . . .

Proctorpak



PROCTORPAK... ... Proctor's Diamond Jubilee Design—the greatest advance in dryer design since the introduction of the continuous conveyor dryer.

PROCTORPAK... ... is the culmination of Proctor's 75 years' experience in designing and fabricating the finest, most effective drying equipment for the process industries.

PROCTORPAK... ... takes less time to erect, saving construction costs and getting your plant on-stream sooner.

PROCTORPAK... ... is being introduced at the 26th Exposition of Chemical Industries. Drop in on Proctor at Booth 684 and become acquainted with Proctorpak—or write today for your copy of the new Proctorpak booklet.

PROCTOR EQUIPMENT FOR THE PROCESS INDUSTRIES

TRAY DRYERS • TRUCK DRYERS • PRE-FORMING FEEDS
CONTINUOUS CONVEYOR DRYERS • SPRAY DRYERS

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Manufacturers of Industrial Drying Equipment and Textile Machinery

PROCTOR & SCHWARTZ, INC.
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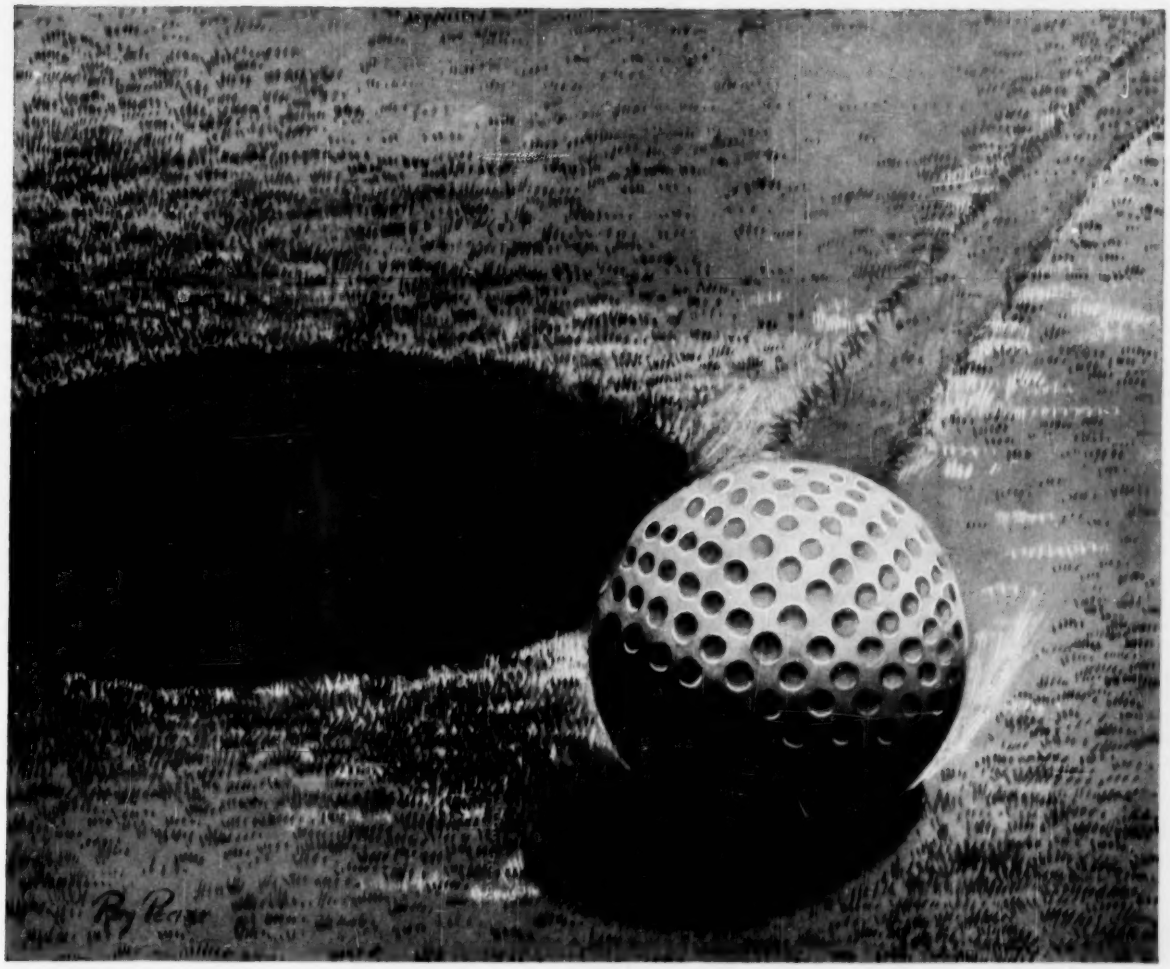

All it takes is practice!

When that ball skims the edge of the cup, you can blame wind, weather, putter, green, your wife's cooking, or a fleeting conflict of ego and libido. But when the shot is sunk, you can credit experience, practice and knowledge of the course. It's the same with titanium.

Titanium can be readily forged, machined, welded, stretched and drawn into shapes having high strength, light weight and superlative resistance to both heat and corrosion. Titanium fabricating, joining and finishing practices are no more difficult than for many other engineering metals, but they are different.

TMCA has accumulated a great deal of pertinent experience and practical data which are available to you on request. Extensive research facilities can also expedite special investigations to answer your specific questions.

TMCA has a selfish reason for helping you "sink the shot" whenever a technical challenge arises. Our Technical Service Department is anxious to discuss your application and cooperate in the establishment of routine fabricating and joining techniques for this outstanding engineering metal . . . now priced competitively.

. . . FIRST IN Titanium . . . . . .

TITANIUM METALS CORPORATION OF AMERICA, 233 Broadway, New York 7, N.Y.

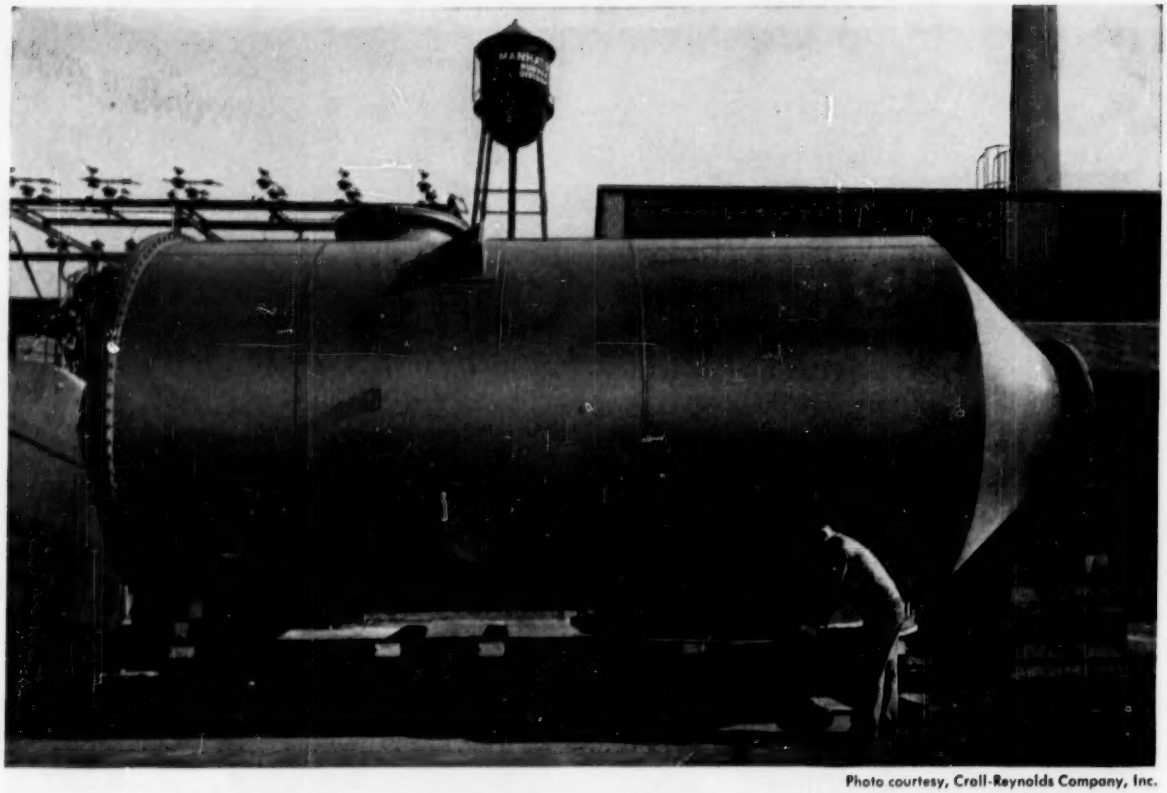

Photo courtesy, Croll-Reynolds Company, Inc.

MANHATTAN ACID-PROOF RUBBER LININGS

Protect One of the World's Largest Rubber Lined Barometric Condensers

This unit measures a big 22 feet long by 10 feet in diameter. And, because every square inch is rubber lined by Manhattan, every square inch is protected against corrosion . . . *permanently!*

Costly process equipment and solutions deserve the degree of protection against corrosion, contamination, and abrasion possible only with specially compounded, acid-proof Manhattan Rubber Linings. These linings are made from thick, multiple calendered sheets of natural or synthetic rubber for maximum durability under your specific conditions. Manhattan engineers have developed a method of bonding the rubber to the metal so securely that actual tests have proved they can't be separated! Manhattan linings expand and contract with the metal under temperature changes . . . they won't harden or crack. Resistance to most acids and alkalis is as positive as advanced technology can provide.

Equipment size or shape is no problem when you rely on Manhattan. If the unit can be shipped, it can be lined at Manhattan. Equipment too large to be shipped can be field lined and vulcanized by skilled Manhattan crews. The most modern and complete lining facilities available today, plus experience dating back to the first tank lined in this country, is ready to handle your job. To make certain your lining is flawless *and* permanent . . . every Manhattan Lined Tank is tested under high voltage.

For *permanent* protection for your equipment and processes, discuss your tank lining requirements with the R/M representative at the Manhattan Rubber Lining plant nearest you . . . Write for new Tank Lining Catalog #7115. RM704

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

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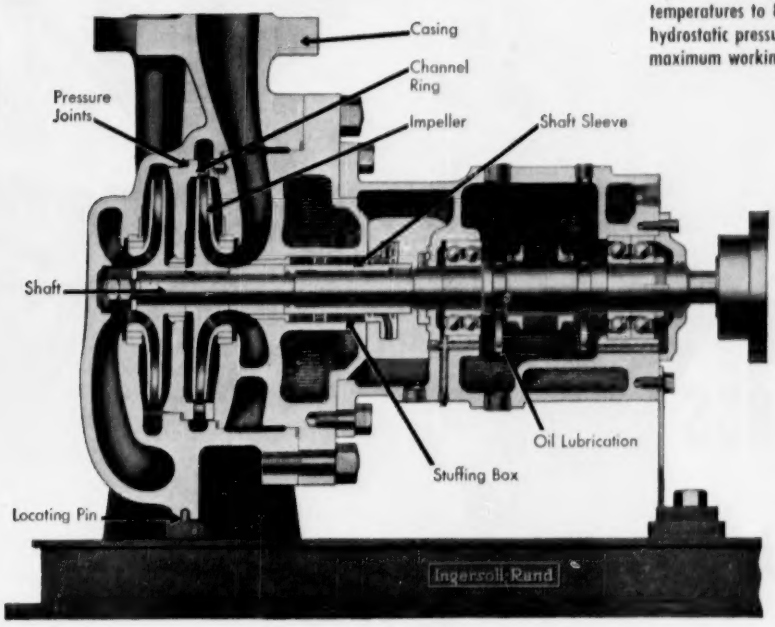
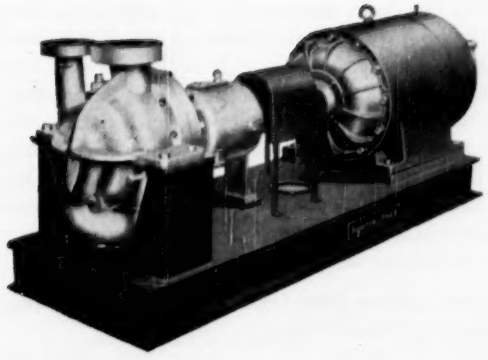
Two-stage Ingersoll-Rand process pumps . . . Class EGT

sizes 1½, 2 and 3 inches . . .
heads to 925 ft. . . .
capacities to 400 gpm . . .
temperatures to 800 °F.
hydrostatic pressure tested to 1200 psi
maximum working pressure . . . 600 psi



designed for hot liquids at high heads

The Class EGT pump described here is one of the many models Ingersoll-Rand builds for process applications. This unit is an overhung, two-stage, single-suction, diffusor – volute type pump with oil-ring lubricated ball bearings. Like all other I-R process pumps, it is built in accordance with latest API specifications. Some of the major features that make the EGT a dependable pump with long-range economy are:



Pump pulls apart from back end . . . vertically-split casing design and spacer type coupling permits dismantling for service or inspection without disconnecting piping or driver.

Center Line Support and Casing locating pin . . . centered at the hot-end of the pump casing, prevent pump from moving in any direction except axially due to expansion encountered on high temperature service . . . thus perfect alignment is assured at all times.

Stuffing box . . . is under suction pressure at all times. It is extra deep to allow packing to be arranged to suit the application. Depending upon the service, single or double mechanical seals can be furnished if desired.

If the EGT or any of the many other standard process pumps do not meet your specific requirements, Ingersoll-Rand has the experience and facilities to design and build a pump for your particular application. For further information call or write the nearest I-R branch office.

Ingersoll-Rand
11 Broadway, New York 4, N. Y.

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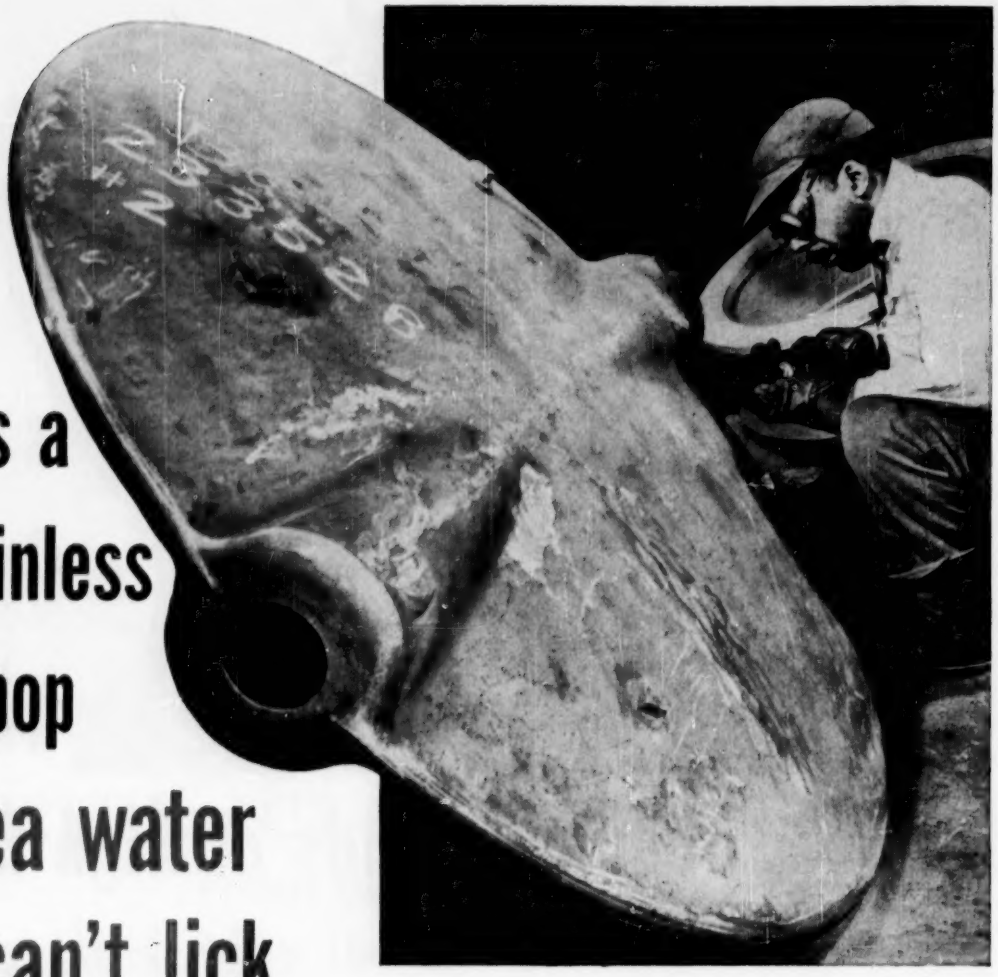
COMPRESSORS • TURBO BLOWERS • CONDENSERS • AIR TOOLS • PUMPS • DIESEL AND GAS ENGINES



Here's a stainless lollipop sea water can't lick

This large (48″ dia., 1701 lbs.) and unusual stainless casting was fabricated by Allegheny Ludlum's Buffalo, N.Y. foundry. It is scheduled for service under the most severe operating conditions, functioning as a wafer valve disc at 25 psi pressure in sea water. Since long life and tight closing are essential in this application, corrosion resistant Type 304 Allegheny Stainless was specified.

Some unusual techniques were employed in the fabrication of this casting. Although the entire valve disc was cast as a single piece, its sides are hollow, with a skin only ¼″ thick. The center shaft was cast solid at the same time the side wings were cored, permitting the single piece, seamless part desired.

If you have a casting problem, or *any* problem that involves corrosion resistance, long life, resistance to wear and abrasion, call the Allegheny Ludlum Sales Office nearest you. An A-L Sales Engineer is ready to put his skills and those of the A-L Technical Staff promptly at your disposal, to serve your requirements from the largest and most complete line of stainless products on the market.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania.

WSW 6663

Write for this 28-page booklet on A-L STAINLESS CASTINGS

28 pages of valuable and complete data on stainless castings: analyses, properties, technical data on handling and heat treatment, typical applications, how to order, etc.

ADDRESS DEPT. CE-96

Make it BETTER and LONGER LASTING with

ALLEGHENY STAINLESS

Warehouse stocks carried by all Ryerson steel plants

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One in a series.

How to Select a Steam Trap Big Enough for the Job

Adequate capacity safety factors are essential to operating efficiency

As promised to you in a previous Armstrong trap advertisement in this publication, here is some helpful information on steam trap safety factors.

First, the definition. A trap safety factor is simply the ratio between actual continuous discharge capacity of the trap and normal condensate load. If the load is 500 lb/hr and the trap actually will discharge at the rate of 1000 lb/hr, the safety factor is said to be 2 to 1, and so on.

Why a Safety Factor?

You are not going to get maximum heat transfer efficiency from any steam heated unit unless your traps are sized with a generous excess of capacity over the normal condensate load.

Remember that trap capacity is given in terms of *continuous* discharge of condensate at a given pressure differential. If you don't employ an adequate safety factor, you make no provision for these requirements or conditions:

1. ***Venting of gas,*** O_2 and CO_2, would be impossible if a trap should discharge a full stream of water continuously.

2. ***Peak loads*** would back up condensate in the line or unit if the trap were sized for average load.

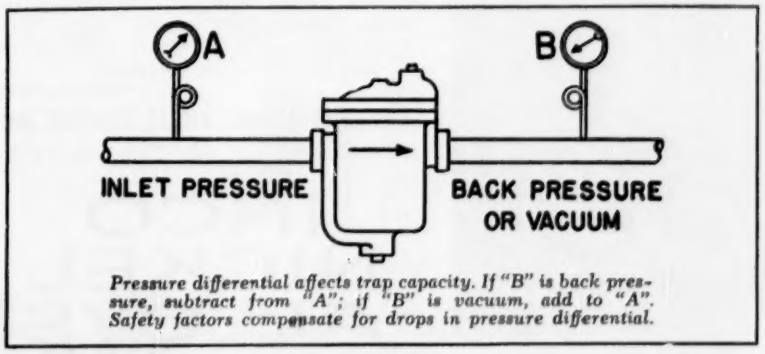
3. ***Reduction in pressure differential*** across the trap orifice would reduce capacity below requirements. If steam pressure drops below normal, trap capacity is lowered more than condensing rate. An increase in back pressure for any reason cuts trap capacity. And, pressure differentials often drop substantially during warming-up periods.

4. ***"Group" trapping.*** Very occasionally it is impractical to use an individual trap on each coil or condensing unit. Here, a generously oversized trap helps prevent backup of condensate or air from one unit to another. The frequent opening of a big trap valve "pumps" non-condensibles and condensate to the drain header.

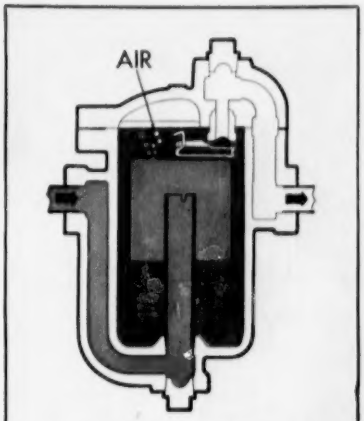
What Safety Factor?

Fortunately, it isn't necessary to calculate safety factors. Experience is the best guide and the benefit of experience with tens of thousands of successful installations is available to you. The following table is taken from the Armstrong Steam Trap Book.

Page	Equipment Drained	Safety Factors
24	Purifiers and Separators	2 or 3 to 1
25	Steam Mains or Headers	2 or 3 to 1
26	Steam Heating Pipes	2 to 1 up to 6 to 1
29	Unit Heaters	3 to 1
30	Submerged Coils	2, 3 or 4 to 1
32	Cylinder Dryers	4 to 1 up to 10 to 1



Pressure differential affects trap capacity. If "B" is back pressure, subtract from "A"; if "B" is vacuum, add to "A". Safety factors compensate for drops in pressure differential.



Traps vent air. This requires a trap capacity safety factor.

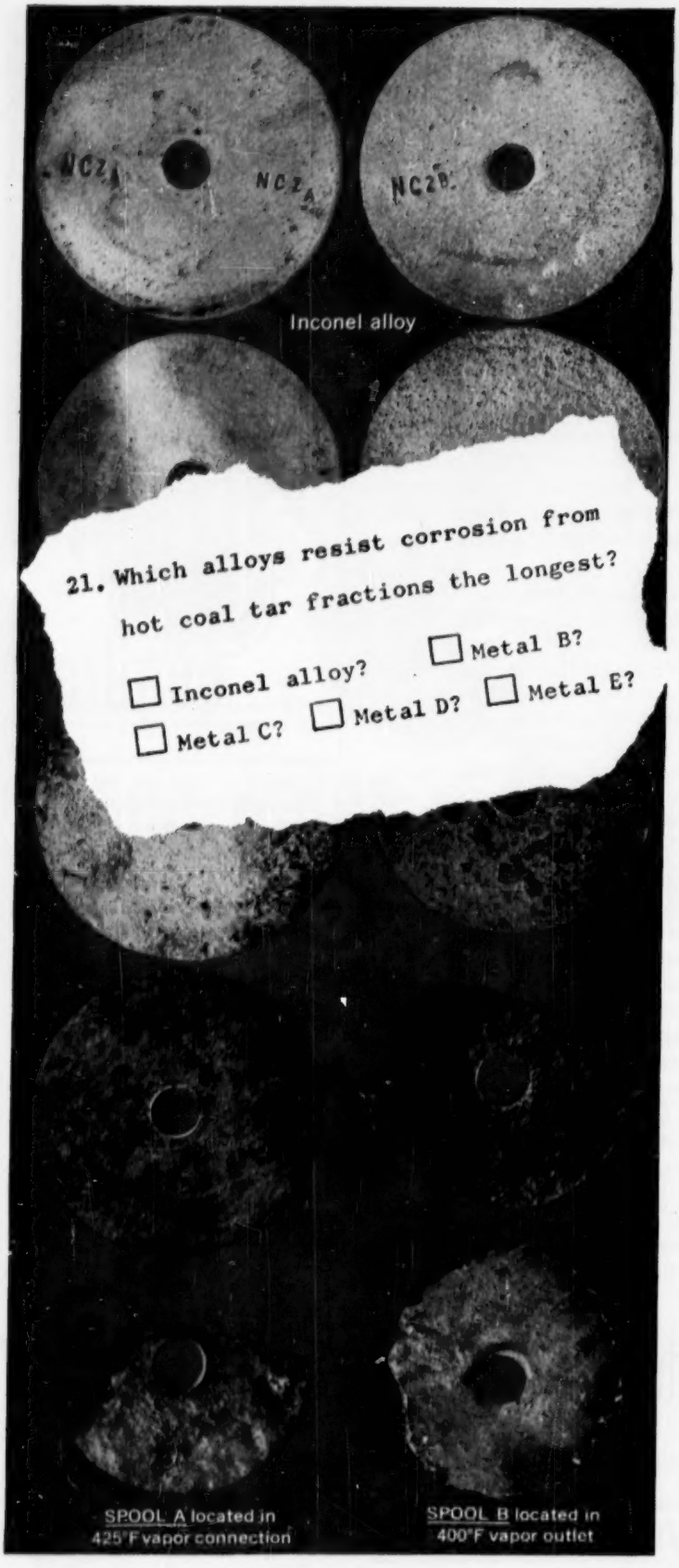
The page numbers listed contain completely reliable data for any trapping job.

CAUTION. The safety factors recommended in The Armstrong Steam Trap Book will have to be increased by an unknown factor for trap capacity ratings based on cold water tests, orifice tests or slide rule calculations. Armstrong trap steam temperature condensate capacity ratings are based on actual operating conditions which take into account such capacity-reducing factors as pipe friction and the choking effect of flash steam.

If you'd like to have a copy of the 44-page Steam Trap Book, just call your local Armstrong Representative, or write the factory. There is no obligation.

Armstrong Machine Works
8583 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS



INCO'S in-plant corrosion tests help you answer this kind of multiple-choice question

The alloy samples shown left and right were exposed to 306 days of corrosion.

They were exposed on standard Inco in-plant corrosion test racks in equipment condensing a coal tar fraction containing 5 lbs./1000 gals. of ammonium chloride at approximately 450°F. Nine different types of ferrous and nickel-base alloys were tested.

The story they tell is clear. In this *particular* equipment, with this *particular* corrosive, Inconel* nickel-chromium alloy is the alloy of choice for longest service life.

To the producer concerned, this information was useful in specifying materials for a new condenser. And, by extension, it should prove useful to other makers of coal tar products. But that's not why we're telling *you* about it.

More important by far! This demonstrates one of the Inco Corrosion Engineering services that help you answer specific questions of material selection.

Nearly always these are multiple-choice questions with, as in this case, thousands of dollars hanging on the answer. What Inco does is to go all-out to get the *factual evidence* you need for decision.

Need Help With a Corrosion Problem of Your Own?

Very often, the answer to a stubborn problem may be found in our codified files, covering thousands of case histories. Where necessary, we will help you initiate an in-plant corrosion test. Simply write to Inco's Development and Research Division. (If you like, we will send you a Corrosion Data Work Sheet, which makes it easy to outline the problem).

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

INCO NICKEL ALLOYS

rough CONDITIONS?

TYPE J
1 TO 30 H. P.
Rerated Frames
182 to 326U

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Protected **AGAINST CORROSION ALL EXPOSED PARTS CAST IRON...**

Rust-resistant solid cast iron withstands abuse, wear and corrosion. *Protects* working parts!

Protected **BY LUBRIFLUSH FOR LONGER BEARING LIFE**

New grease forces old grease out—keeps bearings fully lubricated. *Protects* bearing efficiency!

Protected **AGAINST INTERNAL HEAT WITH ASBESTOS WINDINGS**

Nature's greatest heat resistor, asbestos can't carbonize! *Protects* windings against heat!

Protected **FROM STRESS AND WARP BY NORMALIZING CASTINGS...**

All cast-iron components are heat-seasoned to stabilize molecular structure. *Protected* against warp!

Total Protection in every direction

Large savings are being gained by many industries using *enclosed* motors in place of the usual "open" or ordinary protected motor. U.S. Totally Enclosed gives *total* protection in every direction—from corrosion, dusts, abrasives, impact, weather, spray and splash! This means motor dependability ...long life...savings both on motor costs and production continuity!

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Los Angeles 54, Calif.—Box 2058, Milford, Conn.

Gentlemen: Please send me complete information in your Totally-Enclosed Motors.

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ADDRESS _____

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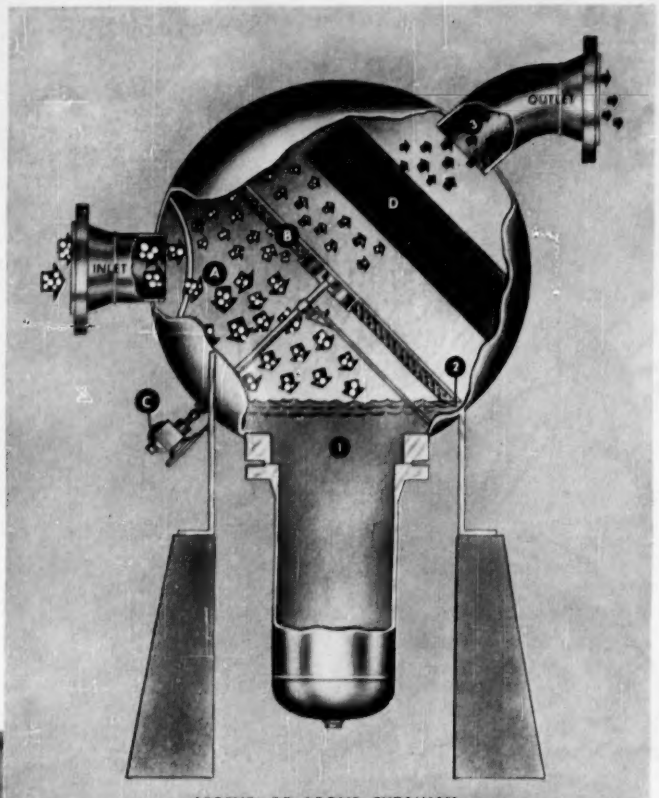
OPERATION PROVES
It's Cleaner Gas with
PEERLESS
SCRUBOSPHERES



LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).

Operation of these four-83" I.D. Scrubospheres has demonstrated their superiority over oil bath dust scrubbers. The dust removal ability of the SCRUBOSPHERE is outstanding because it utilizes wetted surfaces for dust collection which are more closely spaced than in conventional equipment.

Operation of these Peerless units has also proven their superiority with respect to minimum oil loss because oil is periodically removed from the Scrubospheres, whereas it must be periodically added to other scrubbers in the same plant operating under comparable conditions.

Let your Peerless Representative give you full details.

PEERLESS MANUFACTURING COMPANY

Walnut Hill Lane at Old Denton Road
P. O. BOX 13165 • DALLAS, TEXAS
Representatives in All Principal Cities

PEERLESS MFG. CO. DALLAS TEXAS

If you can ... pour it

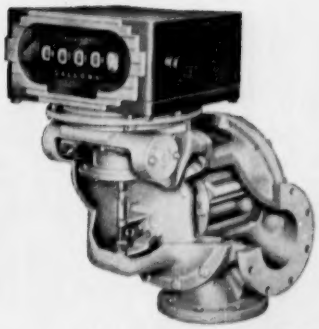
... or pipe it

ROCKWELL CAN METER IT!

including corrosive liquids

Did you know that your company can save important money by using modern measurement methods in handling industrial liquids? With Rockwell meters you can batch, blend and control formulas with precision. You can guard your costly liquid inventories. You can control costs. And with Rockwell automatic quantity control valves you can save time and money on repetitive operations.

Why not investigate all the advantages of liquid metering in your plant? There's a size and type Rockwell meter for practically every service. Use the coupon or write for a free engineering analysis of your liquid handling operations.



ROCKWELL ROTOCYCLE METER
Cutaway to show the all-revolving rotor construction

ROCKWELL
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METERS

STAINLESS STEEL • STEEL • IRON • BRONZE

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Gentlemen:
I am interested in measuring _____
(Name of Liquid)

Pipe Size _____"
Working Pressure _____ psi Temperature _____ °F max.
Max. Flow Rate _____ gpm Min. Flow Rate _____ gpm

Your Name _____
Company _____
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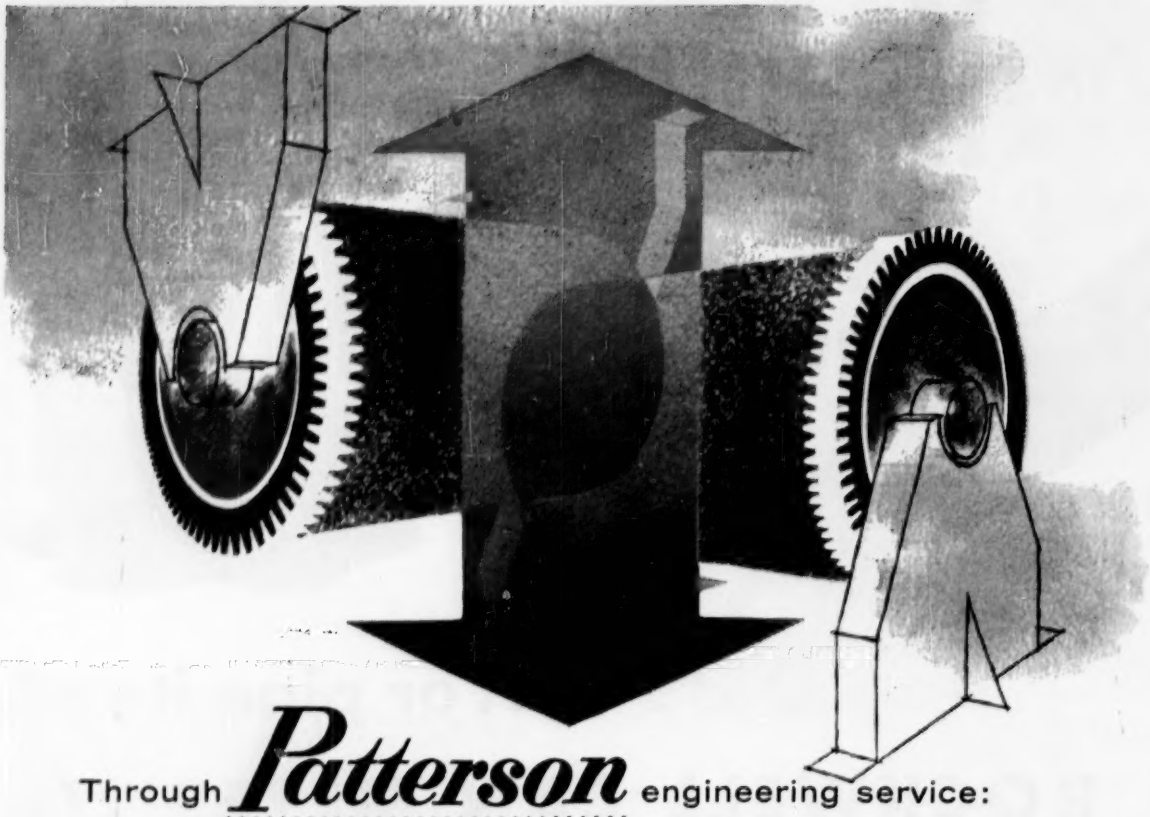
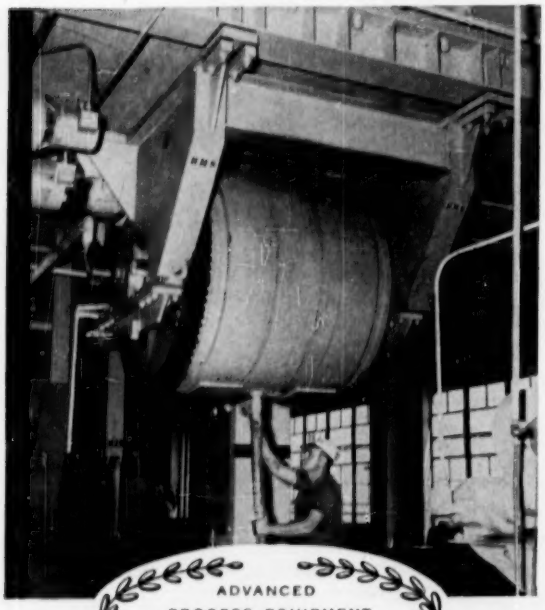
City _____ Zone _____ State _____



Through *Patterson* engineering service:



BETTER GRINDING OPERATIONS

Wherever ball and pebble mills grind, new efficiencies can be developed by skilled operations analysis! For the chemical industry, Patterson engineering service is available for complete grinding room modernization surveys, including equipment relocation, materials handling improvements and all related factors—based on the experience of the Patterson organization in solving industry's grinding problems for more than 90 years. Let us arrange to have a Patterson engineer sit down with you for a preliminary discussion at your convenience, without obligation. **Write us.**

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A Subsidiary of Ferro Corporation

East Liverpool, Ohio

THE *Patterson* FOUNDRY AND MACHINE COMPANY (CANADA) LIMITED

Toronto, Ontario

"OUT IN THE OPEN"

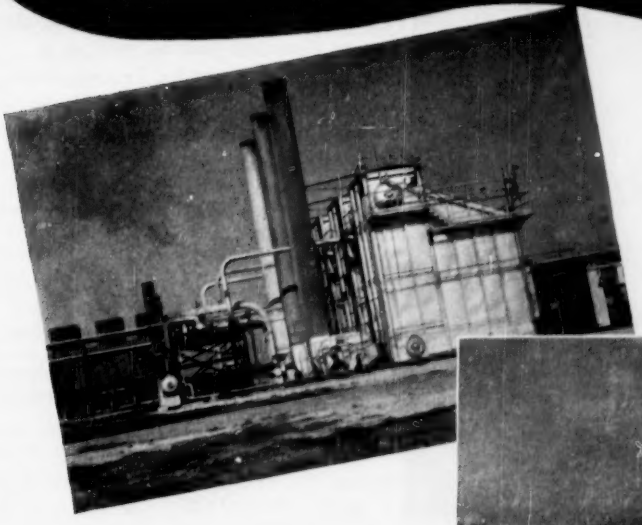
Vogt

Steam Generators

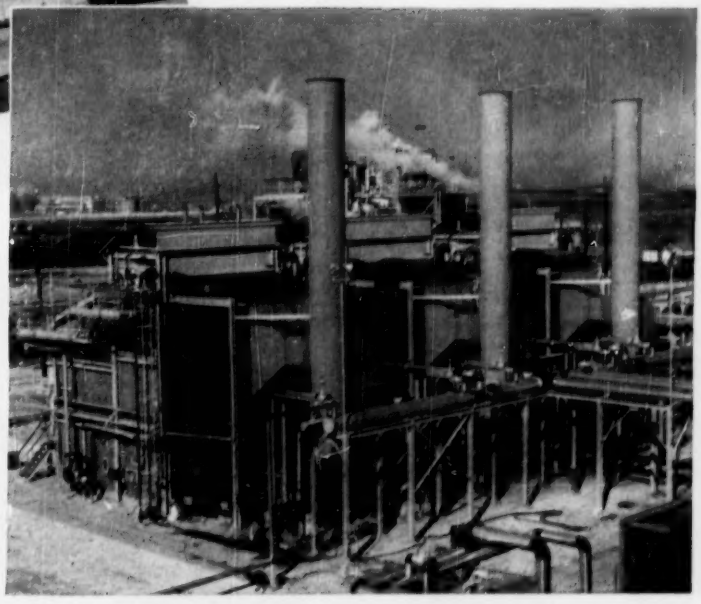
STEAM GENERATORS for economical outdoor operation have been featured by Vogt for many years and serve leading chemical plants and petroleum refineries. Requiring no building for housing, such installations, as pictured here, produce more steam per dollar of investment and are a definite aid to lower production costs.

Get Vogt's recommendations for steam generators to meet your needs for power, processing, or heating, without obligation. Package type and custom built units are available in a wide range of types, capacities, and pressures to meet operating requirements.

Write for bulletins. Dept. 24A-BC



Three 85,000 #/hr. steam generators in a Texas refinery.



An outstanding chemical plant served by three 150,000 #/hr. units.

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there's more to good construction than meets the eye

A fine construction job has a lot of eye appeal. At Procon we're pretty proud of the way our finished projects look. The most satisfaction, though, is in knowing that behind the trim, functional beauty we've put the soundness of design, the careful planning, the quality of construction to fulfill the most exacting operational requirements.

If you want your building project to function just as well as it looks, why not let Procon show you how it's done. We've been building well for the petroleum refining, petrochemical and chemical industries for years.

PROCON *Incorporated*

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The Yarway Impulse started a new era in steam trapping...

... it began in 1935, when Yarway applied a unique principle of thermodynamics to steam traps—and the Yarway IMPULSE Steam Trap was born.

Since then over 1,225,000 Yarway IMPULSE traps have proved themselves so well in service that today many other type traps are regarded as obsolete—an understandable reason why the Yarway IMPULSE type of steam trap is being imitated.

To industry, the Yarway IMPULSE trap makes possible a new high in thermal efficiency of equipment, a new low in trap operating maintenance . . . resulting in increased production and higher profits.

THE THERMODYNAMIC PRINCIPLE

This is the principle on which the Yarway IMPULSE trap design is based—that variations in temperature of water discharging through two orifices in series cause variations in pressure in an intermediate chamber between the orifices, and that these changes in pressure may be utilized to open and close the trap valve.

ONE MOVING PART

There is only one moving part in a Yarway IMPULSE trap—a small, stainless steel valve. The entire valve assembly can be replaced in 5 or 6 minutes. It is the simplest of all steam traps to service.

EQUIPMENT HOTTER, SOONER—STAYS HOT

At "start up" the little valve opens wide to discharge air and condensate continuously. This brings equipment into production in the quickest possible time. The valve then actually floats on the condensate load, maintaining highest, steady temperatures.

A YARWAY IMPULSE STEAM TRAP TO MEET EACH TRAPPING REQUIREMENT

Research and development in the Yarway Steam Laboratory, plus intensive field testing, have produced a line of steam traps—*all* of the Yarway IMPULSE type . . . to efficiently meet each of the following classes of trapping service:

Normal requirements for pressures up to 600 psi call for Yarway Series 60 and 120 IMPULSE Traps in six sizes, ½" to 2".

Light loads for pressures up to 600 psi call for the ½" Yarway No. 20-A and No. 120-A IMPULSE Traps.

Heavy loads for pressures to 600 psi call for the extra high capacity Series 40 Yarway IMPULSE Trap, available in five sizes, ½" to 2½".

Highest pressure and marine requirements up to 2500 psi are met by the Yarway Integral-Strainer IMPULSE Trap, in six sizes, ½" to 2", flanged, screwed and socket weld types.

PLUS ADVANTAGES

- Small size and light weight
- Easy, low cost installation
- Minimum maintenance
- Non-freezing
- Stainless steel construction
- No adjustment of valve or seat needed for any pressure
- Low initial cost

NATIONALLY STOCKED, SOLD AND SERVICED

Over 270 Industrial Distributors stock and sell Yarway IMPULSE Steam Traps . . . and over 35 Yarway field engineers are available to help you select the right steam trap for the job.

Write for free, new bulletin "*The Why and How of Steam Trapping.*"

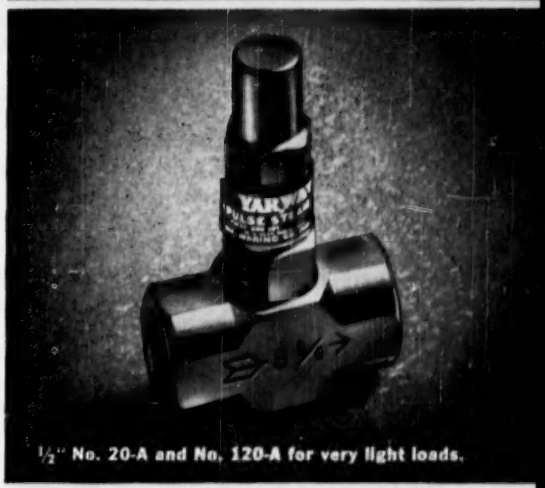
YARNALL-WARING COMPANY

187 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY impulse®

...a good way to specify steam traps

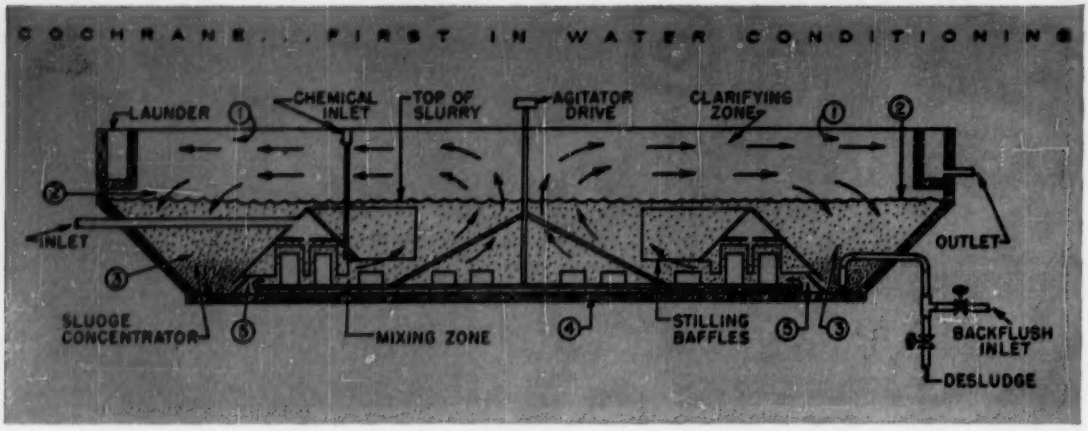
Series 60 and 120 for normal requirements.



½" No. 20-A and No. 120-A for very light loads.

Series 40 for very heavy loads.

Integral Strainer Impulse Traps for highest pressures and marine use.



A **Cochrane** solids contact reactor is designed to provide the ultimate in clarification

Cochrane suspended solids contact coagulating and softening clarifiers are packaged units that combine a mixing zone at the bottom with a clarifying zone above.

A bottom agitator in the mixing zone keeps old precipitates in constant suspension. Thorough mixing and contact between the old and new precipitates is thus assured. This results in a more complete reaction with a minimum in chemical requirements and retention time. In the clarifying zone the water is effectively separated from the slurry precipitates and clarified.

The Cochrane reactor design is unique in its baffle and agitator arrangement, as follows:

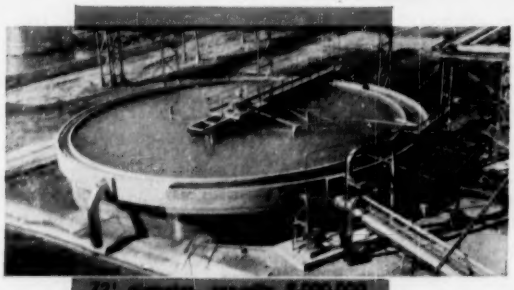
① Radial *Horizontal* Flow—*Not Upflow*. Velocity decreases from center to launder. Slurry particles separate more efficiently from horizontal flow than from upflow.

② Slurry flow is *downflow* in clarifying zone below collecting launders—*not upflow*—thus preventing carryover of turbidity into effluent.

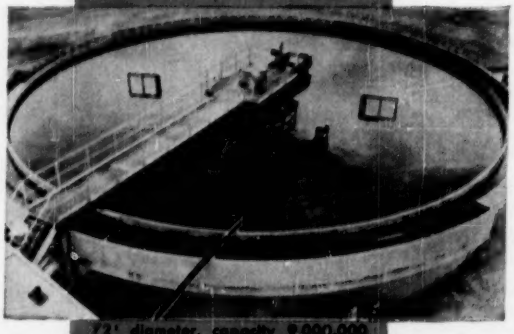
③ Sludge settles only in annular *concentrator* outside of mixing zone. Maximum concentration results because no turbulence is present. This feature saves wastage of water in desludging.

④ There is no premature loss of slurry strength in mixing zone because no sludge settles on the floor of mixing zone.

⑤ Turbulence in mixing zone assures excellent mixing. A large, full-diameter agitator causes centrifugal outward flow, against the diverting baffle in front of the outer port and turns flow inwardly towards central port.



73' diameter, capacity 9,000,000 GPD located in Georgia.



72' diameter, capacity 9,000,000 GPD located in Texas.

Two units 83' diameter—capacity 20,000,000 GPD located in Washington.

Cochrane
CORPORATION
3113 N. 17TH STREET, PHILADELPHIA 32, PENNA.
NEW YORK • PHILADELPHIA • CHICAGO

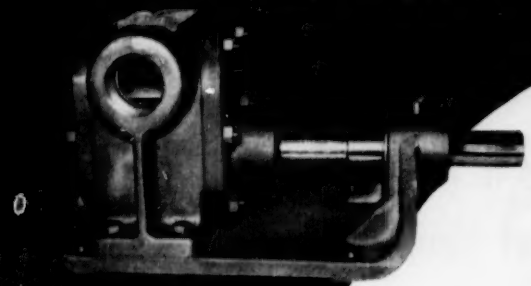
Cochrane Water Conditioning Ltd., Toronto 4, Montreal 1, Winnipeg 1, Canada.

Representatives in Thirty Principal Cities in U.S., San Juan, Puerto Rico; Honolulu, Hawaii; also: Paris, France; La Spezia, Italy; Mexico City, Mexico; Havana, Cuba; Caracas, Venezuela; San Diego, Chile; Manila, Philippine Islands.

Pottstown Metal Products Div.—Custom built carbon steel and alloy products

Demineralizers • Hot Process Softeners • Hot Zeolite Softeners • Dealkalizers • Reactors • Deaerators • Continuous Blowoff Systems Condensate Return Systems • Specialties

NEW
TWIN-LOBE
Positive Displacement
PUMP*



Manton-Gaulin presents a completely new concept in rotary positive displacement pumping — The Gaulin Twin-Lobe*® design.

The two big features are simplicity and performance — results of a radically new "Twin-Lobe" pumping principle. Look at these advantages:

- Simple construction, only three moving parts.
- High mechanical efficiency, lower horsepower required.
- High vacuum, self-priming. Efficient enough to move volatile gases or extremely viscous liquids.
- Wide range of uses — handles corrosive and abrasive materials.
- Special alloys used throughout for long wear, precision fit.

Send for New G. T. A./TLP-57 Bulletin!

Complete description, data sheets and application guide are now available. Find out how the new Twin-Lobe pump can save money, improve quality.

One Basic Design good for many uses

Liquids, heavy slurries, pastes, soft food solids, emulsions, gases, and light non-lubricating liquids

*Pat. Pending

Capacity and size range

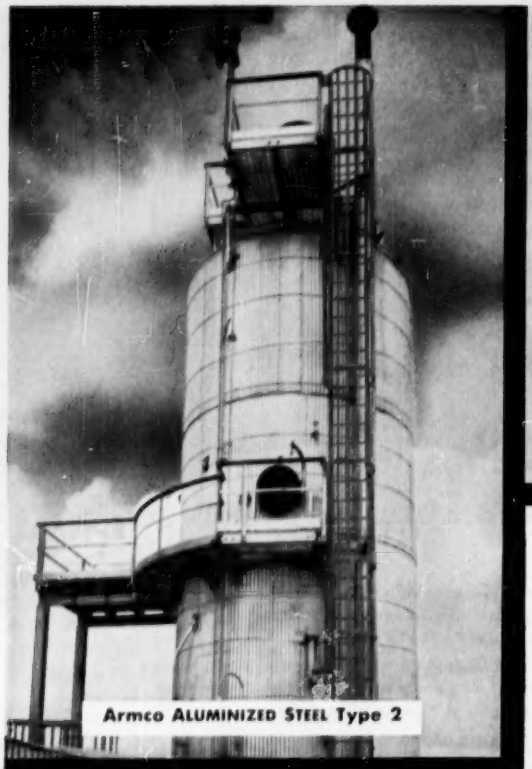
Three models now available. Capacities: 0-56 gpm; Pressures: 0-200 psi.

Gaulin

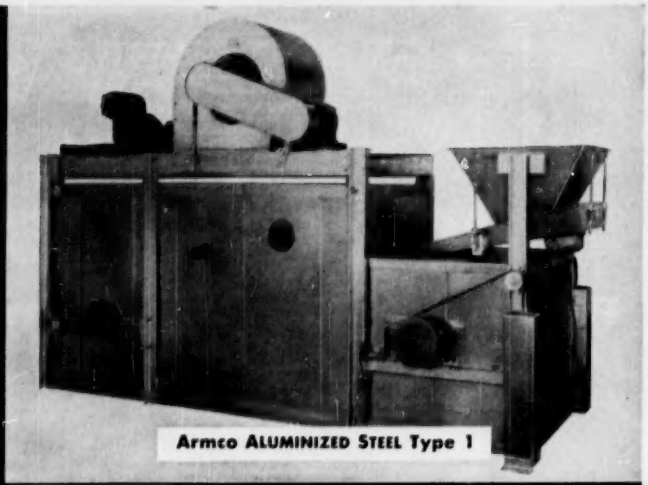
MANTON Gaulin

71 GARDEN ST. EVERETT 49, MASS.

World's largest manufacturers of stainless steel reciprocating, rotary, pressure exchange pumps, dispersers, homogenizers and colloid mills.



Armco ALUMINIZED STEEL Type 2



Armco ALUMINIZED STEEL Type 1

Armco Stainless Steel

How Armco Special Steels Cut Maintenance and Production Costs

Hot-dip aluminum coated steels and stainless steels with special properties create opportunities to combat rising costs

Armco ALUMINIZED STEEL® Type 1—This hot-dip aluminum coated steel offers high heat reflectivity, the strength of steel and excellent resistance to a combination of heat and corrosion, ALUMINIZED STEEL Type 1 has proved ideal for insulating covers on processing vessels, furnace walls, dryers, boiler shrouds and similar applications. Its unique properties mean improved efficiency and durability.

Armco ALUMINIZED STEEL Type 2—Another special hot-dip aluminum coated steel, ALUMINIZED STEEL Type 2 provides excellent resistance to atmospheric corrosion plus the strength and rigidity of steel. Tests show the special aluminum coating has three times the life of a zinc coating on unpainted commercial galvanized sheets. Ideal for rain shields, jacketing for outdoor vessels and reactors, and buildings.

Armco Stainless Steels—Special extra-low carbon grades simplify welding; unique precipitation-hardening types combine unusually high hardness and strength with good corrosion resistance. These and other Armco Stainless Steels reduce maintenance, insure low cost production and transportation of contaminant-free products.

See Us in Booths 1221-25

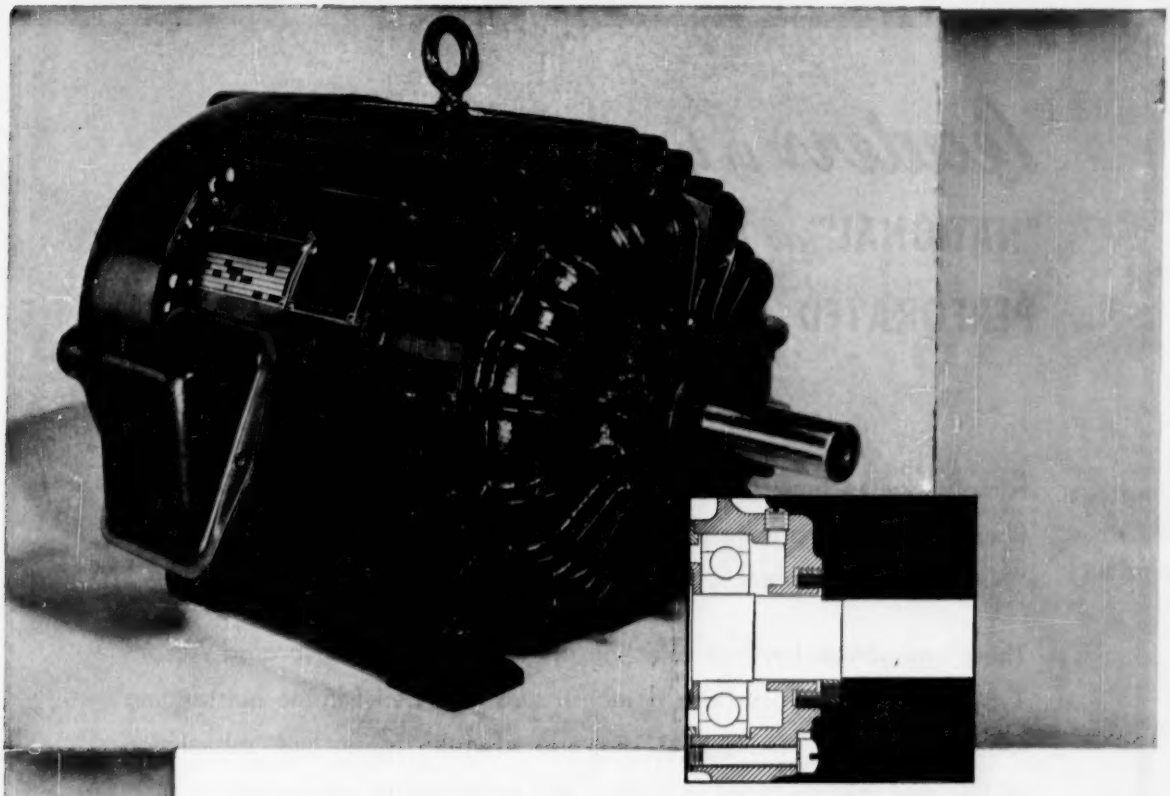
You are cordially invited to visit the Armco exhibit in Booths 1221-23-25 at the 26th Exposition of Chemical Industries, New York Coliseum—December 2-6.

Demonstrations will show how each of these Armco Special Steels can be used to increase efficiency and cut costs of chemical processing equipment. Armco corrosion engineers will be on hand with the data and information you need.

ARMCO STEEL CORPORATION

2427 Curtis Street, Middletown, Ohio

SHEFFIELD DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION



Securely sealed for low maintenance —

TOTALLY ENCLOSED FAN COOLED MOTORS

When motor maintenance goes down, production goes up. Century TEFC Motor *protects itself* from dust, grit, chemical fumes, moisture. Shaft openings at each end are labyrinth-sealed, and there is a precision clearance between metal seal and bearing bracket.

Outside, a hose or whisk broom quickly cleans it. External fan forces jets of cooling air across the frame. Inside, vital motor parts are completely sealed off from injurious atmosphere. Factory lubrication of bearings is adequate for several years' service under normal conditions; however, whenever required bearings may be relubricated through grease plugs.

For full facts on your specific application, call the Century District Office or Authorized Distributor nearest you.

CENTURY . . . building TEFC Motors for 25 years

CE-88

Performance-Rated®
MOTORS
1/20 to 400 H.P.

CENTURY ELECTRIC COMPANY

1806 Pine Street • St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

Leaders in Your Industry Have Selected "NATIONAL" *as the Leader in the Field of* PERFORATED APRON-TYPE CONVEYOR DRYERS

Famous names among the manufacturers and processors of chemicals, fibers and allied products are proudly listed in the growing roster of "NATIONAL" customers.

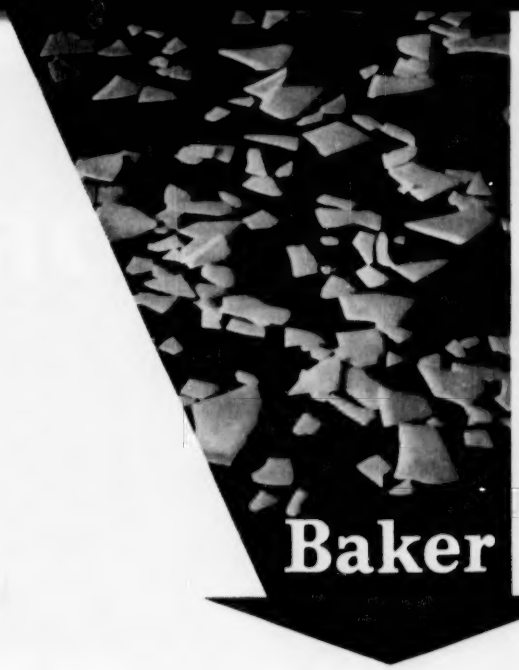
These companies, by their selection of "NATIONAL" Perforated Apron-Type Conveyor Dryers, have demonstrated their belief in the outstanding leadership which "NATIONAL" has earned in the design and construction of this and related types of drying and conditioning equipment.

AMERICAN VISCOSE CORPORATION
ARMOUR & COMPANY
THE PHILIP CAREY MANUFACTURING CO.
DAVISON CHEMICAL COMPANY
DIV. OF W. R. GRACE & CO.
DU PONT COMPANY OF CANADA (1956) LTD.
E. I. du PONT de NEMOURS & CO.
THE GENERAL TIRE & RUBBER CO.
CONGOLEUM-NAIRN, INC.
O. M. SCOTT & SONS CO.
A. E. STALEY MANUFACTURING CO.
AMERICAN ENKA CORP.
NATIONAL ANILINE DIVISION, ALLIED CHEMICAL & DYE CORP.
NATIONAL METAL EDGE BOX CO.
CANADIAN INDUSTRIES, LTD.
RADIO CORPORATION OF AMERICA
THE DOW CHEMICAL CORP.
CHEMSTRAND CORP.

• *Watch This Space in Future Issues for Case Histories*
Send for Literature or Representative, without Obligation

THE NATIONAL DRYING MACHINERY CO.
LEHIGH AVENUE and HANCOCK STREET
PHILADELPHIA 33, PENNA.

New England Agent: JONES & HUNT, INC., Gloucester, Mass. *Cable Address:* "NADRYMA"-W. U. Code



Here's news!

Baker CALCIUM NITRATE, Tech.
ZINC NITRATE, Tech.

in THIN FLAT FLAKES

- *Faster dissolving*
- *Uniform purity—lot after lot*
- *Controlled water of hydration*
- *Easier to handle*

Look over the photograph above, reproduced to actual size. Note the thin flakes with large surface area. THIN FLAKES go into solution FAST – you save time and money. They are easy to handle. These chemicals in *flake* form represent another Baker first.

Latex processors gain better control of coagulation because of the controlled high assay and known water of hydration. This uniform purity, controlled pH and freedom from extraneous matter insure better quality in your finished goods with fewer rejects.

These chemicals are produced to meet precise specifications. In the informative typical analysis shown below, note the very low ammonium nitrate content in Baker Calcium Nitrate. The exceptionally low copper and manganese contribute to longer life for your latex products, with less tendency to oxidize and become brittle or too soft.

These features of Baker Calcium Nitrate and Zinc Nitrate also are helpful to manufacturers of rustproofing specialties, textile finishes, pigments, adhesives and lithographic materials.

Because of the low melting points and deliquescent nature of these chemicals, they are packaged with polyethylene liners and are stored in an air conditioned warehouse at a temperature below 85°F.

Write for samples and prices for these new *flaked* products, Calcium and Zinc Nitrate Technical.

CALCIUM NITRATE, Technical Flake — *Typical analysis*

Assay (as $Ca(NO_3)_2$)	70.8 %
Water of Hydration	28.6 %
Insoluble and NH_4OH Ppt.	0.03 %
Ammonium Nitrate (NH_4NO_3)	0.1 %
Magnesium & Alkalies (as NO_3)	0.4 %
Iron (Fe)	0.0003%
Copper (Cu)	0.0004%
Manganese (Mn)	0.001 %
pH of 5% Solution	6.0

Thin (0.023 in.) flakes about ½ inch in size with the following typical mesh analysis:

On U.S. No. 4	45%
Thru U.S. No. 20	8%

ZINC NITRATE, Technical Flake — *Typical analysis*

Assay (as $Zn(NO_3)_2$)	74.2 %
Water of Hydration	25.6 %
Insoluble Matter	0.008 %
Iron (Fe)	0.001 %
Lead (Pb)	0.005 %
pH of 5% Solution	5.1

Thin (0.035 in.) flakes about ½ inch in size with the following typical mesh analysis:

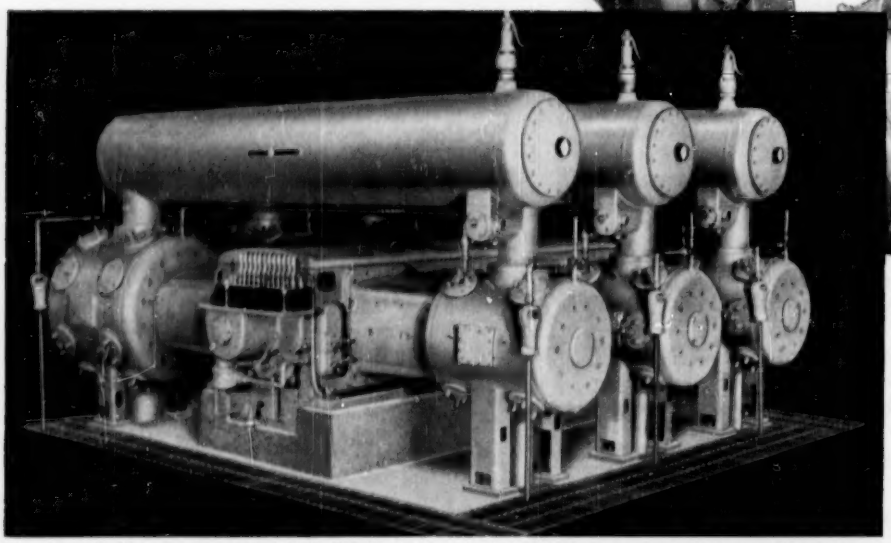
On U.S. No. 4	26%
Thru U.S. No. 20	9%

PURITY BY THE TON
–for production use

J. T. Baker Chemical Co.
REAGENT · CHEMICALS · FINE · INDUSTRIAL
Phillipsburg, New Jersey.

BUILT FOR

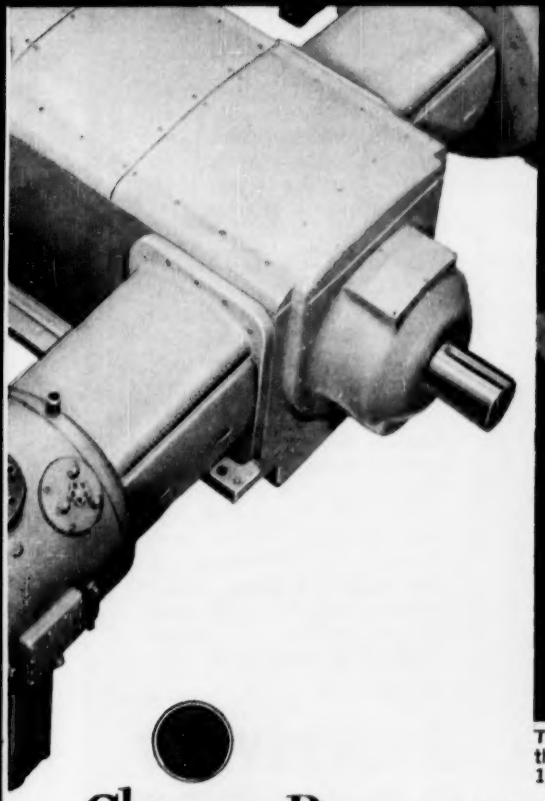
CLASS FE

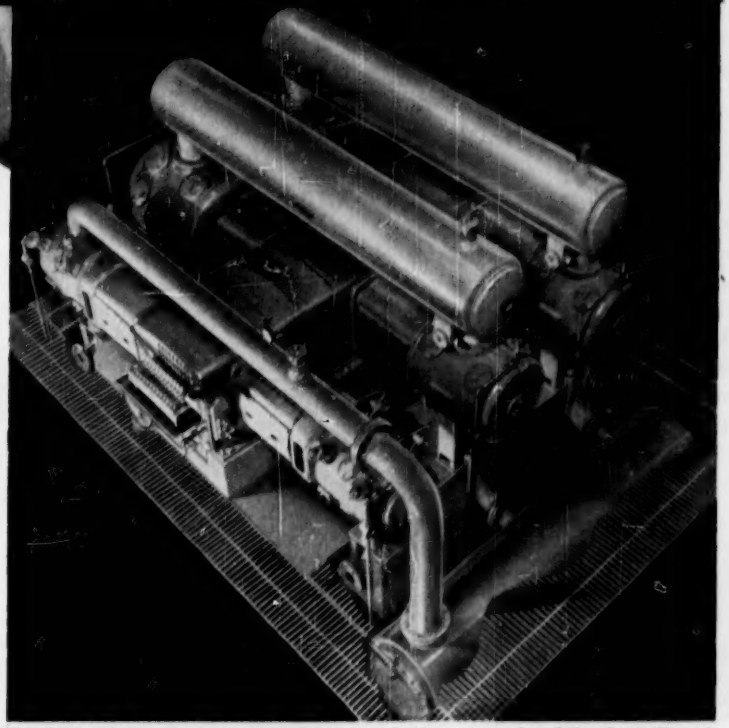


The six-cylinder compressor unit in the background photo above represents but one of numerous cylinder-crankthrow arrangements obtainable with the balanced-opposed Class FE. The unit shown directly above is a two-stage arrangement, 1000 H.P. size, one of two recently purchased by a large engine manufacturer.

HEAVY-DUTY

COMPRESSORS





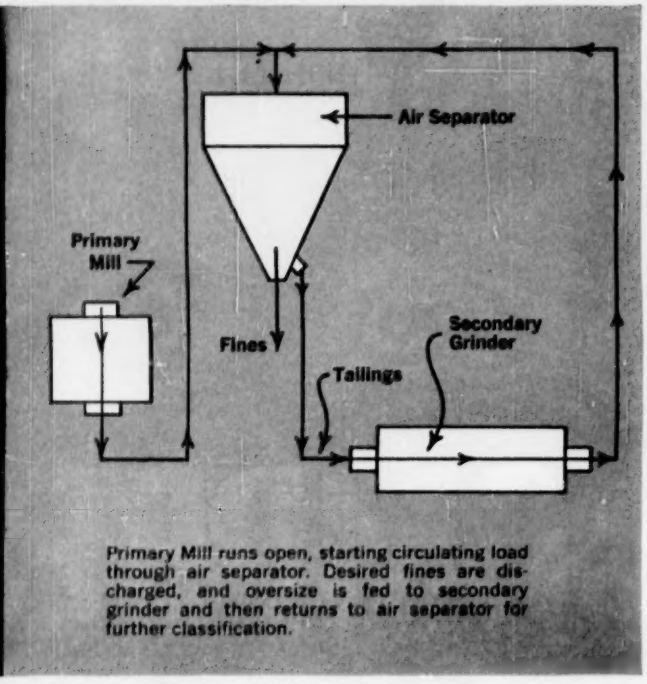
The high pressure compressor above is a further example of the flexibility of the balanced-opposed design. Here, the six-cylinder arrangement is used in a 1,250 H.P. three-stage compressor for wind tunnel service.

Chicago Pneumatic

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

Stop Overworking Grinding Mills

FEED SPOUT
Sturtevant Air Separators come in 9 models, diameters range from 3 to 18 ft.
TAILINGS DISCHARGE
FINES DISCHARGE



Primary Mill runs open, starting circulating load through air separator. Desired fines are discharged, and oversize is fed to secondary grinder and then returns to air separator for further classification.

LET STURTEVANT AIR SEPARATION HELP YOUR SYSTEM PRODUCE UP TO 300% MORE 40 TO 400 MESH FINES — CUT POWER COSTS AS MUCH AS 50%

Fines that pass through grinding mills unhindered, serving only to increase the work load, can be quickly classified by a Sturtevant Air Separator operating in closed circuit. With all oversize automatically returned for further grinding, the result is production capacity impossible to achieve in single-pass grinding — as well as a better, more uniform product.

Closed circuit grinding and air separation is of proved advantage in *all* secondary reduction processes. Grinding mills are free to perform at top efficiency, their output frequently increased as much as 300% and power costs cut up to 50% (documented by 30 years of Sturtevant air separation experience in the cement industry). Further, attritional heat is dissipated by greater surface exposure.

Sturtevant Air Separators Keep Grinding Units At Peak Efficiency — Classify Feed Loads to 800 Tons Per Hour

Sturtevant Air Separators circulate production loads with exact control of air currents and centrifugal force. Simple adjustments make possible counter-action between the two to the point where a product of almost any desired fineness may be collected while coarser sizes are rejected.

A 16 ft. Sturtevant, for example, took a feed rate of 800 tph, containing only a small percentage of desired fines, and delivered 30 tph 90% 200 mesh, recirculating the oversize through the grinding circuit. (In the cement industry, Sturtevant units deliver up to 60 tph raw cement fines, 40 tph finished cement fines.)

Sturtevant's ability to engineer precise, high capacity classification for closed circuit grinding systems is the result of long experience with a wide variety of dry processes. Sturtevant designed its first air separator some 40 years ago — and has been pioneering developments in centrifugal classification ever since.

Current users of Sturtevant Air Separators include manufacturers of sulfur, soybeans, phosphate, chocolate, feldspar, sand, pigments, limestone fillers, abrasives, plasters, ceramics and cement.

Designed for precise separation of all granular materials, Sturtevant Air Separators have been adapted to other materials as well. Johns Manville, for example, uses a 10 ft. model to separate 3 to 6% undesirable rock from asbestos.

Ruggedly constructed, Sturtevant units are designed for minimum maintenance — at a Midwestern rock-crushing plant, a 10 ft. Separator operates outdoors yearround with only routine care.

For further information, request Sturtevant Bulletin No. 087. Write Sturtevant Mill Co., 100 Clayton St., Boston 22, Mass.

STURTEVANT

Dry Processing Equipment

CRUSHERS • GRINDERS • MICRON-GRINDERS
SEPARATORS • BLENDERS • GRANULATORS
CONVEYORS • ELEVATORS

FOR SALE

Commercial-grade zirconium sponge

(hafnium-containing)

Commercial-grade zirconium is now for sale in tonnage quantities — from Columbia-National in sponge form or as rod, sheet and tubing from the country's leading mills.

You can put commercial-grade zirconium to work:

- To combat severe corrosion in the process industries.
- For prototype or experimental work in the nuclear energy field.

To help you investigate and use zirconium, Columbia-National offers experienced technical assistance on melting, fabricating and alloying.

New Technical Digest now ready! Write for data on properties and applications of commercial-grade zirconium.

NEW METALS FOR INDUSTRY

Columbia-National Corporation

Jointly owned by Columbia-Southern Chemical Corporation and National Research Corporation

Dept. C-4-D — 70 Memorial Drive, Cambridge, Mass.

See us at the Chemical Show, Dec. 2-6, Booth No. 1044

Traffic World, Sept. 21

'Major Potential' for Tank-Car Builders Is Maximum-Load Cars, Says ACF Official

J. P. Krumech Tells National Petroleum Ass ... That Such Cars For High-Pressure Commodities Are Possibl ... Fleets.

Oil Daily, Sept. 13

Rising Trend to Large Capacity Tank Cars Cited at NPA Parley

ATLANTIC CITY, Sept. 12—J. P. Krumech, vice president of Shippers' Car Line division, ACF Industries, Inc., today told the tran...

The ACF official acknowledged that there are some ... for oil companies ...

Wall Street Journal, Sept. 13

New High-Pressure Tank Cars Expected to Be In Production Shortly

By a WALL STREET JOURNAL Staff Reporter

NEW YORK—Larger, maximum-load tank cars for high-pressure commodities—liquefied gases—will soon be out of the development stage and in large-scale production, according to J. P. Krumech, vice president in charge of sales of Shippers' Car Line division of ACF Industries, I...

Four points that made news highlighted the talk given by ACF Industries' J. P. Krumech at the National Petroleum Association's annual meeting in Atlantic City on Sept. 12.

1. Money-saving maximum-load railroad tank cars for many commodities are available now;
2. For *petroleum products*, 19,000-gallon cars with 90 per cent greater lading capacity than 10,000-gallon cars cost only 27 per cent more;
3. For *high-pressure commodities* (liquefied gases), 20,000-gallon cars are practical and are now in the development stage;
4. Uninsulated tank cars (only recently approved by the ICC for high-pressure ladings) cost less and carry more.

A qualified leader of today's trends, ACF has built maximum-load tank cars for heavy low-pressure commodities since 1929 ...maximum-load cars for petroleum products since 1953...uninsulated cars for high-pressure commodities since July of this year. ACF has delivered more King Size fuel-oil tank cars than any other manufacturer, and continues to advance its research on maximum-load tank cars for high-pressure commodities.

Additional information is available at:

SHIPPERS' CAR LINE
DIVISION OF ACF INDUSTRIES INCORPORATED
30 CHURCH STREET, NEW YORK 7, N. Y.
WOrth 4-3010

Sales Offices: Chicago, Ill. • Houston, Tex. • San Francisco, Cal. • Cleveland, Ohio • Tulsa, Okla.

19,000-GALLON ACF KING SIZE TANK CAR for petroleum products (right) has 90 per cent greater capacity than standard car, costs 27 per cent more.

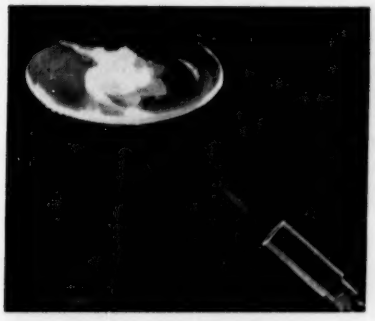
BRIEFS for buyers of

Inert Lubricants

Phosphoric Anhydride

Hypophosphites

Sodium Sulfide and Sulfhydrate



You can't burn this grease

Besides being completely nonflammable, this grease won't break down in the presence of oxygen, hydrogen peroxide, concentrated mineral acids and alkalies.

It's unaffected by heat up to 300° C; is stable at very low temperatures, too; is odorless and nontoxic.

What's its name? FLUOROLUBE®. It's a high-density addition polymer of trifluorovinyl chloride. The basic polymer can be fractionated into many grades, ranging from low-viscosity colorless oils through heavy oils to opaque greases. All have excellent lubricating qualities.

What can you do with them? Some suggestions: lubricate ultraprecision instruments; seal pumps, valves, pipe joints in equipment handling oxygen, hydrogen peroxide, nitric acid, and other corrosives; lubricate PVC fittings, plug cocks, vacuum pumps in highly corrosive service.

You'll find other ideas on use, plus specifications and typical properties, in a data file on FLUOROLUBES which you can get by checking the coupon.

Phosphoric anhydride

Every now and then another new use is discovered for *phosphoric* anhydride, P_2O_5.

This OLDBURY chemical has much to offer if you're looking for a strong drying agent or a high-purity condensation agent.

One of the strongest known desiccants, P_2O_5 contains no sulfates, and only 2 ppm chlorides. Its purity, 98% min., is a distinct advantage in one of its major uses—as a condensing agent in making clear methacrylate resins.

Among the interesting applications for P_2O_5 is a recently developed use in a uranium extraction process.

If you'd like to know more about versatile phosphoric anhydride, for now or later, just check the coupon.

Hypophosphites, N.F. grade

If you use hypophosphites in your own processing, you'll be interested in these three reasons for choosing OLDBURY® hypophosphites:

1. There's a wide selection. Three of the most commonly used are mentioned below.
2. They're high-purity materials, produced in stainless steel equipment. Those listed below all meet N.F. requirements, assaying 98% min.
3. They're readily available. In at least one case, Hooker is your sole U.S. source.

Calcium hypophosphite, $Ca(H_2PO_2)_2$, finds use in medicinals and in organic syntheses. It forms soluble salts, so it is a highly effective means of retaining phosphorus in solution.

Potassium hypophosphite, KH_2PO_2, is also used in pharmaceutical manufacture.

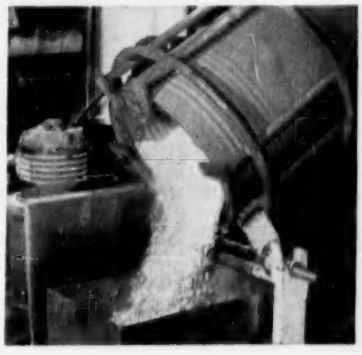
Sodium hypophosphite, $NaH_2PO_2.H_2O$, is a strong reducing agent and antioxidant. Its uses, actual or potential, include: deamination *via* reduction of diazo derivatives; inhibition of rancidity in flour, meat, and other foods. A commercial grade for electroless nickel plating is also available.

These three hypophosphites are shipped in fiber drums, 25 to 50 lbs. net. For complete information on any of them, just check the coupon.

Save time handling sulfides in new fast-pouring drum

You'll like the way you save time with this new 400-lb. drum in which you can now purchase Hooker sodium sulfide and sodium sulfhydrate. Your operators will like its convenience, too.

The opening is 18 inches in diameter —four inches wider and 65% larger in area than the former container.



Easier to empty This drum is much easier to empty with a scoop or shovel. It saves time when pouring, too. Flakes don't pile up around the opening when the drum is inverted.

There's no increase in price for the new drum. To get this extra convenience, just specify *Hooker* sodium sulfide or sodium sulfhydrate on your next order.

For more information on chemicals mentioned on this page, check here:

- ☐ FLUOROLUBES
- ☐ Calcium Hypophosphite
- ☐ Potassium Hypophosphite
- ☐ Sodium Hypophosphite
- ☐ Sodium Sulfide
- ☐ Sodium Sulfhydrate
- ☐ Phosphoric Anhydride
- ☐ New list of products—Bulletin 100-A

Clip and mail to us with your name, title, and company address.

(When requesting samples, please use business letterhead.)

HOOKER ELECTROCHEMICAL COMPANY

412 FORTY-SEVENTH STREET, NIAGARA FALLS, N. Y.

Niagara Falls Tacoma Montague, Mich. New York Chicago
Los Angeles Philadelphia Worcester, Mass.
In Canada: Hooker Chemicals Limited, North Vancouver, B. C.

HOOKER CHEMICALS PLASTICS

BALL MILLS

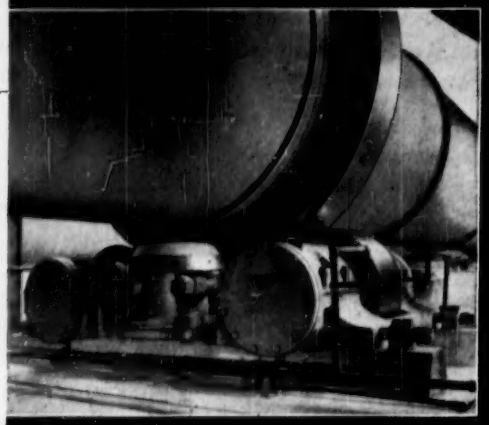
ROTARY KILNS

APRON FEEDERS

PRIMARY GYRATORY CRUSHERS

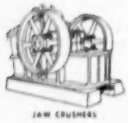
TRAYLOR-MADE

is engineering precision



Thrust roller mechanism of an 8'—6" diameter to 7'—10" diameter x 400'—0" Traylor Rotary Kiln.

13'—0" diameter to 10'—0" x 200'—0" Traylor Rotary Kiln.



JAW CRUSHERS

SECONDARY GYRATORY CRUSHERS

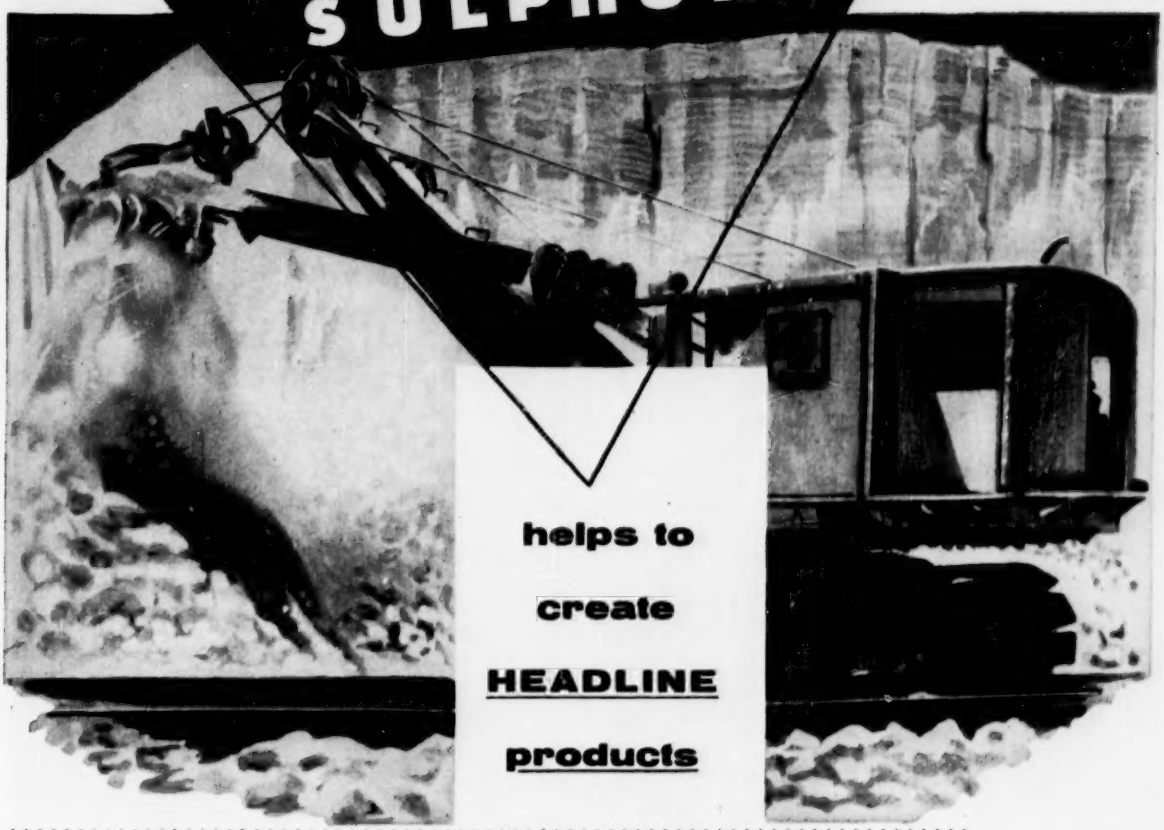
Outstanding Traylor Roller Supports insures easy alignment, continuous operation and low maintenance of kilns, coolers, dryers and slakers. Hundreds of rotary kilns are being used in industry today reflecting the soundness of design and high standards of Traylor craftmanship. Traylor rotary kilns have all welded steel shells-feed and discharge end seals, heat recuperating chain systems for wet process kilns, improved kiln feeders, kiln controls, drives and many other important features. Write for bulletin #1115 today!

Traylor

TRAYLOR ENGINEERING & MFG. CO., MILL ST., ALLENTOWN, PA.

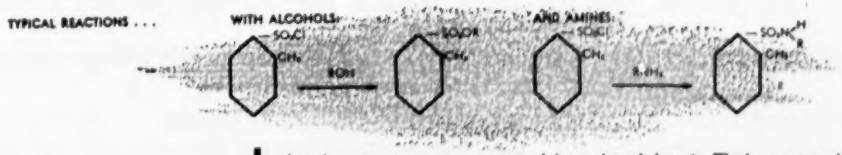
Sales Offices: New York — Chicago — San Francisco
Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P.Q.

SULPHUR



helps to create HEADLINE products

o-TOLUENESULFONYL CHLORIDE*



Industry has a new working tool in o-Toluenesulfonyl Chloride. This 98% pure ortho isomer can be used in building molecules for use in a wide variety of new products, from dyestuffs to pharmaceuticals; from plasticizers to herbicides. It is even possible that it is now being used in products you are making or have recently acquired.

From the chemical name of o-Toluenesulfonyl Chloride it is obvious that sulphur is a component of this compound . . . added evidence of the important role Sulphur plays in our industrial economy.

Product of Monsanto Chemical Company

Texas Gulf Sulphur Co.

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- Newgulf, Texas
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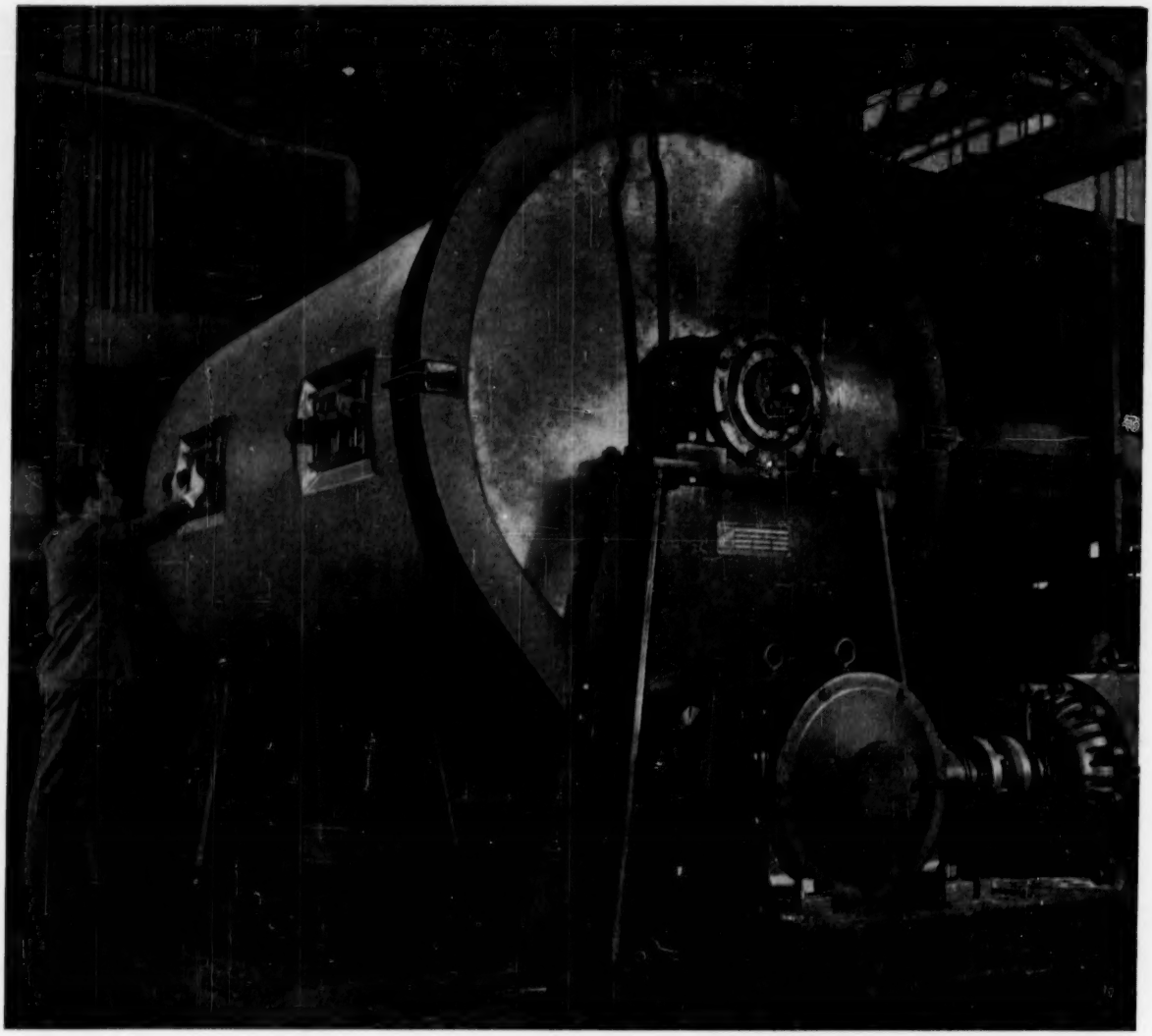
- Spindletop, Texas
- Worland, Wyoming



Bigger process equipment helps fight the profit squeeze

The economic squeeze play, which finds many producers caught between rising costs and shorter profit margins, is likely to continue through 1957. In the process industries, the gap can often be widened by increasing productivity per machine hour. Dravo large scale or special purpose process equipment is ideally suited to this job.

The king size ball mill shown above is a case in point. Designed to meet specific grinding and batch size requirements, it is constructed of stainless steel. All the internal welds are ground flush and the interior polished to a smooth finish. Internal corners are provided with fillets to facilitate cleaning between batches. This large ball mill is helping the owner to step up production rate.

This type of equipment has helped many processors lick production problems by reducing labor cost. And frequently, by bringing design into complete harmony with process requirements, special purpose equipment can achieve astonishing cost reductions.

Take advantage of the engineering skill and fabricating facilities which Dravo can bring to bear on process equipment problems. Write to Dravo Corporation, Pittsburgh 25, Pa.

DRAVO
CORPORATION

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

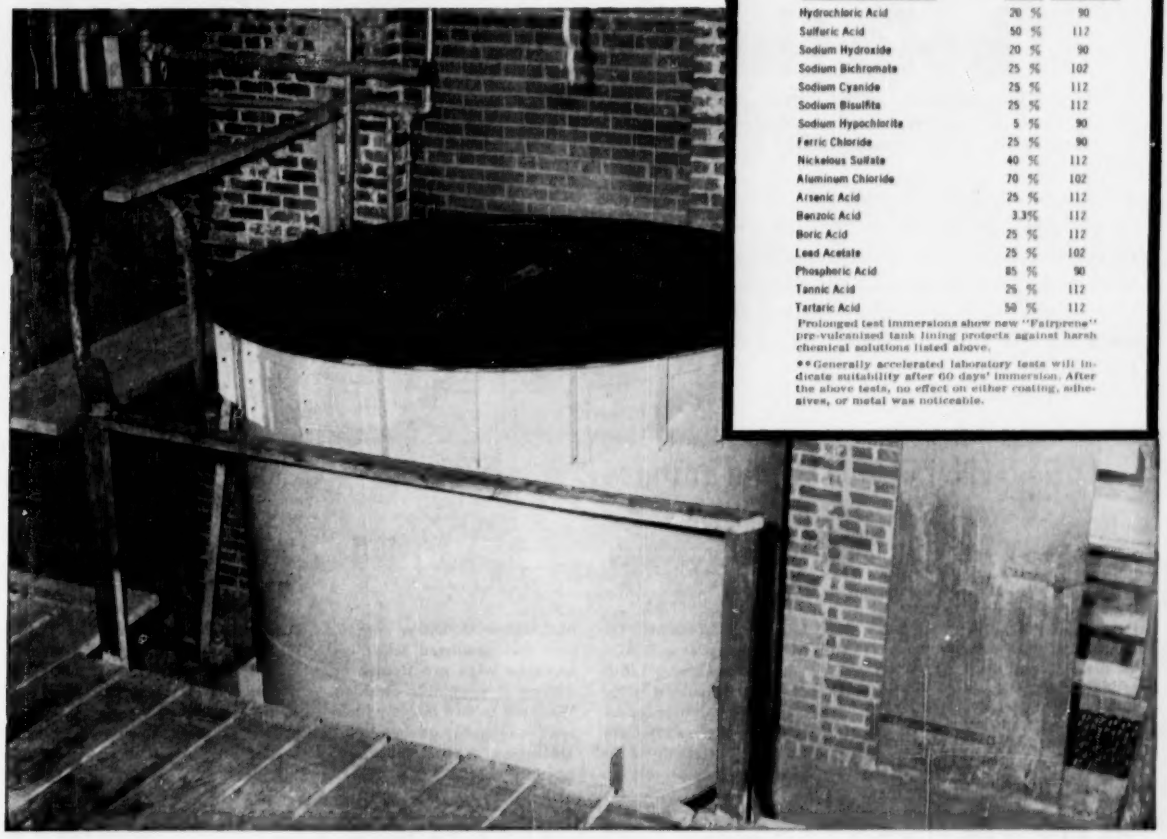
NEW—protective lining sheet that needs no vulcanizing

IMMERSION TEST TABLE
Steel Panels Covered with "Fairprene" in Corrosive Solutions at 212°F.

Immersion Medium	Conc.	No. Days**
Hydrochloric Acid	20 %	90
Sulfuric Acid	50 %	112
Sodium Hydroxide	20 %	90
Sodium Bichromate	25 %	102
Sodium Cyanide	25 %	112
Sodium Bisulfite	25 %	112
Sodium Hypochlorite	5 %	90
Ferric Chloride	25 %	90
Nickelous Sulfate	40 %	112
Aluminum Chloride	70 %	102
Arsenic Acid	25 %	112
Benzoic Acid	3.3%	112
Boric Acid	25 %	112
Lead Acetate	25 %	102
Phosphoric Acid	85 %	90
Tannic Acid	25 %	112
Tartaric Acid	50 %	112

Prolonged test immersions show new "Fairprene" pre-vulcanized tank lining protects against harsh chemical solutions listed above.

**Generally accelerated laboratory tests will indicate suitability after 60 days' immersion. After the above tests, no effect on either coating, adhesives, or metal was noticeable.



Economical new pre-cured Fairprene® lining material provides superior protection against hot corrosive solutions

Because Du Pont's new "Fairprene"* protective lining material is pre-vulcanized, Livingstone Coating Corp., custom applicators, were able to line the above tank on location. "Fairprene" protects against chemical action that would corrode the tank and contaminate the solution it contains at North Carolina Finishing Co., Salisbury, N. C.

"Fairprene" sheet stock is made specifically for protective lining which offers outstanding resistance to harsh chemicals, ozone, oxidation, aging and abrasion. "Fairprene" shows superior heat resistance—can be used at temperatures as high as 200°F. Lining costs are reduced because "Fairprene" is pre-cured. It needs no special storage or shipping conditions, does not deteriorate with age and can be applied on location to minimize equipment downtime. Du Pont "Fairprene" lining is offered in a complete system of materials including sheet (rolls 50" wide and ⅛" thick), tape, cements, activators and putty.

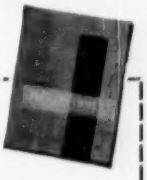
Find out more about the low-cost protection you can give your equipment with "Fairprene" protective lining material. Mail the coupon.

DU PONT INDUSTRIAL COATED FABRICS SHEET STOCKS • CEMENTS

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

*"Fairprene" is Du Pont's registered trademark for its coated fabrics, sheet stocks and cements.



E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, CE-712, Wilmington 98, Del.
Please send me your booklet on "Fairprene" pre-vulcanized protective lining.

*Name*_____ *Position*_____

*Company*_____

*Address*_____

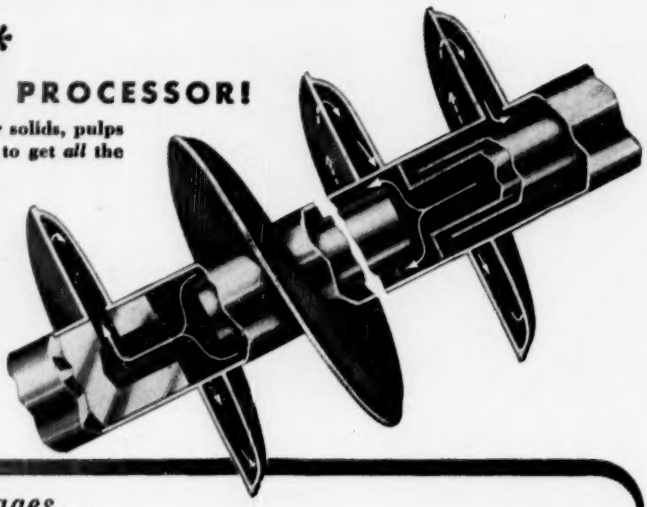
*City*_____ *State*_____

if you have a Cooling...Heating...or Drying problem

investigate the revolutionary advantages of...

THE holo-flite* PROCESSOR!

If you have processes where slurries, granular solids, pulps or pastes are cooled, heated or dried, be sure to get *all* the facts on HOLO-FLITE advantages.

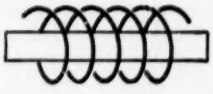


HOLO-FLITE handles such processes — *in continuous flow* — in as little as 1/5th the space of other types of heat exchangers. What's more, it is readily adaptable to a wide range of applications — is simple to install and maintain — and provides many other important savings.

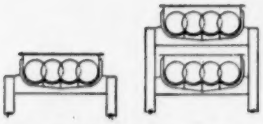
typical HOLO-FLITE *advantages...*

ITS APPLICATION FLEXIBILITY is almost unlimited. It cools, heats, or dries. It handles granular solids, pulps, pastes, slurries and fluids with equal ease. Its heat transfer agent can be water, refrigerant, hot oil, Dowtherm, steam or other liquids or vapors at any of a wide range of temperatures. It cools materials in ranges from 1800°F to 0°F. It heats and dries with hot oil to 600°F...with Dowtherm to 750°F...with steam to 150 lbs. per sq. in. pressure.

THE LARGE HEAT-TRANSFER SURFACE saves space — HOLO-FLITE requires as little as 1/5th the space of other heat-exchange equipment of comparable capacity. Moreover, a more complete heat transfer is effected, resulting in more uniform processing.



ROTATION IS SLOW — granular and powdered solids are handled with practically no dusting — negligible abrasion. There are no dust recovery problems — a further saving in installation, maintenance and operating costs!



ITS OPERATING CAPACITY is readily adaptable to virtually any requirements by simply varying the diameter, pitch, and length of flights, as well as the number of "tiers." Multi-tier units require no more floor space than single-tier installations!

Send for a Free 8 Page Bulletin which gives further time, space and money-saving details on Holo-Flite installation and operating advantages!

*T.M. Reg. (HOLO-FLITE)

HOW HOLO-FLITE WORKS...

Basically the HOLO-FLITE consists of one or more flights of hollow-bladed screw conveyors. The product to be processed moves through a trough housing the conveyor screws. The heat-transfer fluid circulates through the hollow blades and shafts of the conveyor. The product is constantly rotated into, around, under and over the blades and shafts through which the heat-transfer fluid is circulating, assuring quick, uniform heat passage between the two mediums — *as the product is continuously moved along in a bulk-flow without interruptions!*

There are many money and time-saving applications for the Holo-Flite wherever products are cooled, dried, heated or even calcined. Let our engineers study *your particular* problem and make helpful recommendations. No obligation, of course!

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MULTICLONE Mechanical Collectors
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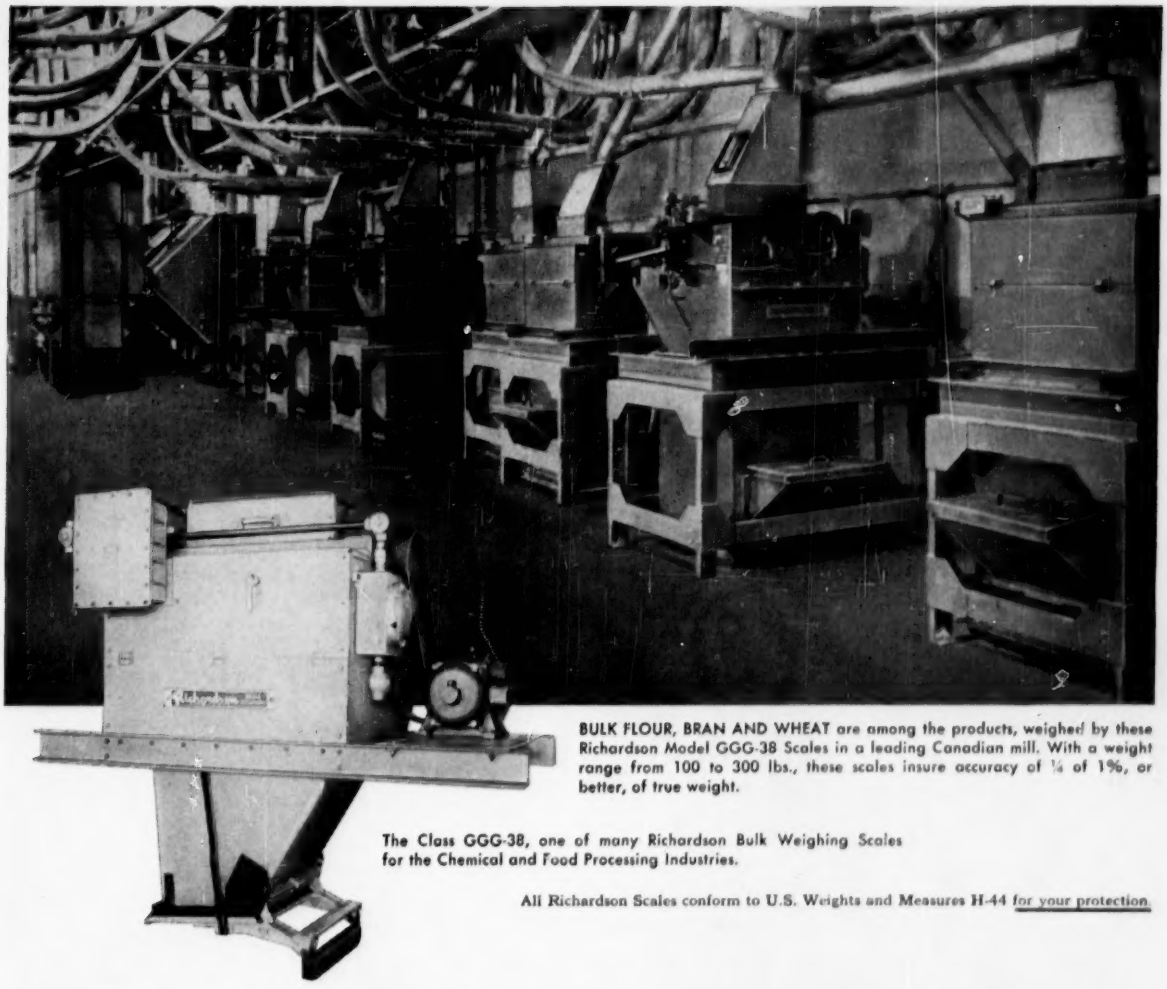
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors



BULK FLOUR, BRAN AND WHEAT are among the products, weighed by these Richardson Model GGG-38 Scales in a leading Canadian mill. With a weight range from 100 to 300 lbs., these scales insure accuracy of ¼ of 1%, or better, of true weight.

The Class GGG-38, one of many Richardson Bulk Weighing Scales for the Chemical and Food Processing Industries.

All Richardson Scales conform to U.S. Weights and Measures H-44 for your protection

Want to slice costs in weighing bulk materials?

Let Richardson Do It For You

Today's automated bulk materials handling systems demand scales that can give accurate, trouble-free service on the widest possible range of materials. That's why Richardson scales are used the world over—by chemical plants, food processors, feed and flour mills.

In unit weighing, process weighing or proportioning operations, you get:

- **REDUCED PRODUCTION COSTS** . . . weighing speeds suit any operation, pace production at economical level.
- **LONG-TERM RELIABILITY** . . . year-after-year rugged, accurate service.
- **SAVINGS IN TIME** . . . equipment stays "on stream," requires minimum maintenance or adjustment.
- **SAVINGS IN MATERIALS** . . . average accuracies of from 0 to ± 3 ozs. guard against losses.
- **SAVINGS IN LABOR** . . . completely automatic equipment means reduced labor and handling expenses.
- **QUALITY CONTROL** . . . accurate measurement keeps quantities and proportions constant.

There's a national service organization behind every Richardson application—to keep your scales in prime condition and to advise you on special weighing and materials handling problems. Let us put to work for you our more than 55 years experience in the business of materials handling by weight. For more information call or write us today.

Richardson

MATERIALS HANDLING BY WEIGHT SINCE 1902

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Sales and Service Branches in Principal Cities

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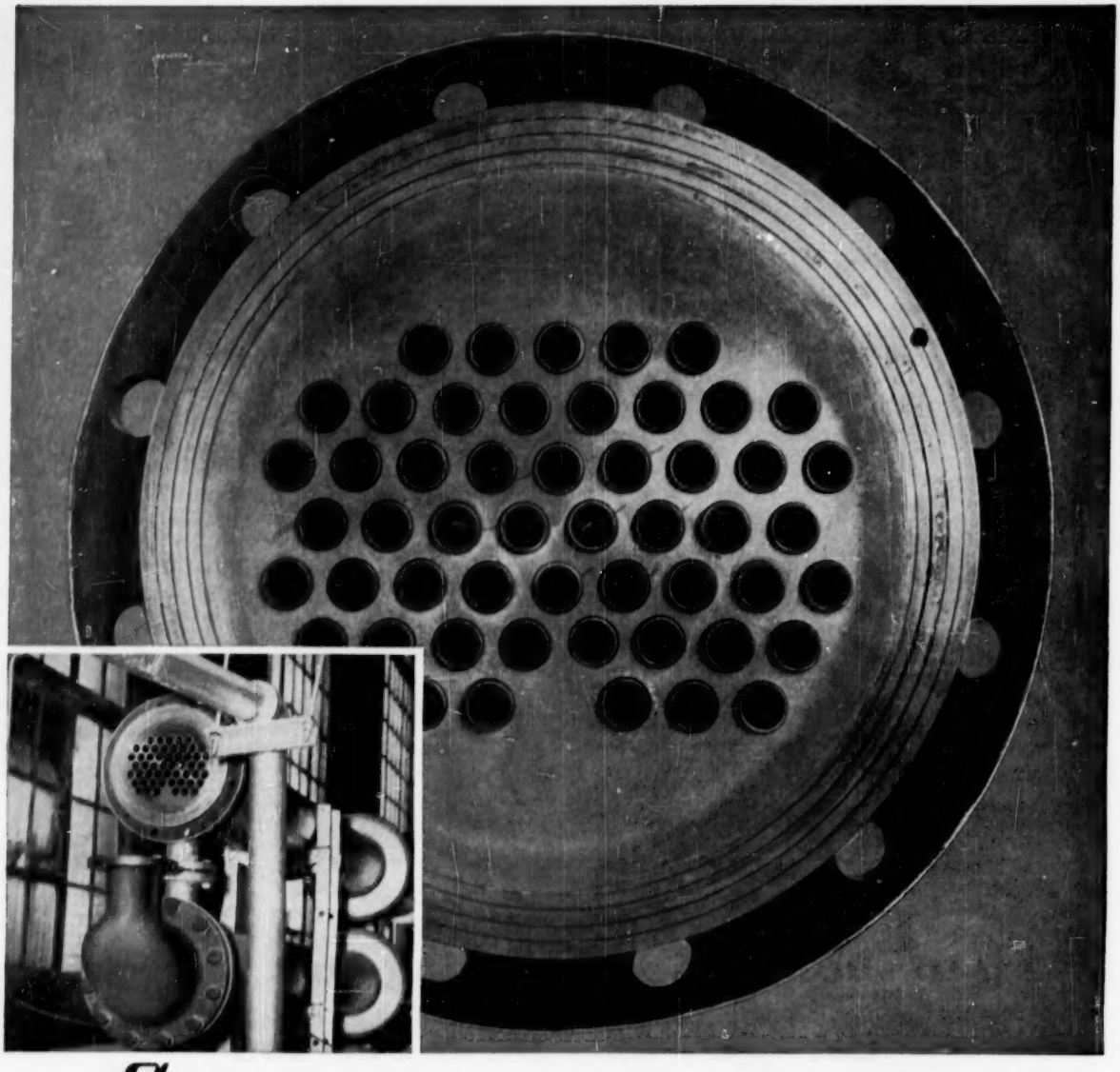

Carpenter 7Mo Stainless Tubing

No corrosion . . . no pitting after 4 years of handling hot SO_2 gases and vapors

• The smooth, clean surfaces of the Carpenter 7Mo Stainless tubing in this 3-pass Relief Gas Cooler tell the whole story. Still like new after 4 years of carrying 8% SO_2 gases and vapors from the top of a sulphite digester at temperatures in excess of 200°F. No maintenance. No replacement worries. No costly downtime.

If you have a tough corrosion problem involving stress corrosion cracking and pitting, see what Carpenter 7Mo Stainless Tubing and Pipe can do to solve it for good. Call your Carpenter Distributor for service that satisfies.

MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

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FROM THIS POSITION AND PLACED AT
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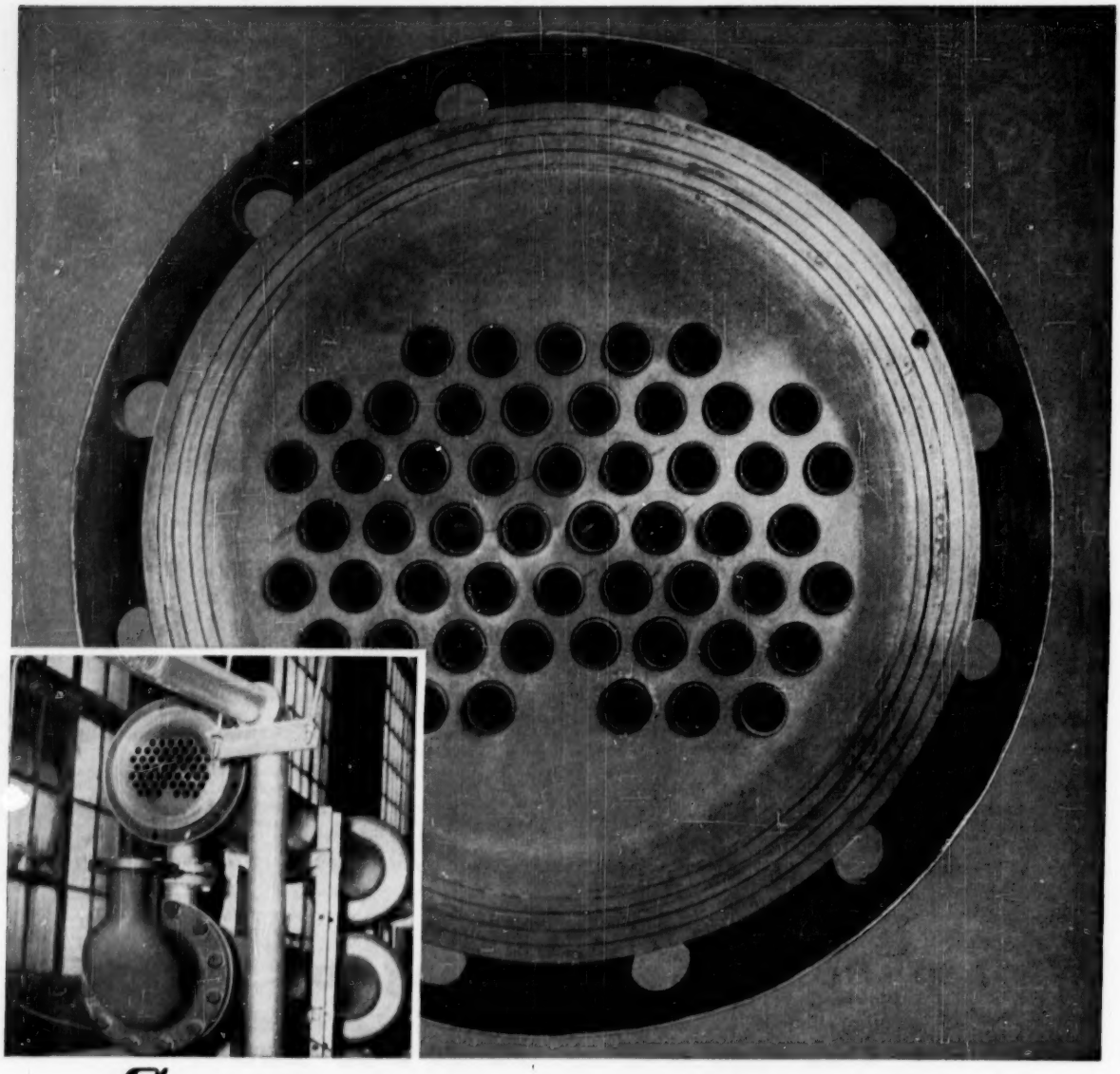
THE CONVENIENCE OF READERS.



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Stainless Tubing & Pipe

TRUFIN TYPE L/C IS IDEAL TUBE FOR AIR COOLERS

Wolverine Trufin Type L/C is a specialized tube developed by Wolverine Tube after years of research. It is particularly effective in such applications as air cooled gas coolers, air cooled water coolers, air cooled hydrocarbon condensers and air cooled steam condensers—to name but a few.

Trufin L/C's construction features an outer tube of high-finned aluminum tube mechanically bonded to an inner liner of such metals as copper, Admiralty, 85-15 red brass, low carbon welded steel, 90-10 and 70-30 cupro nickel—among others.

Wolverine Trufin Type L/C is available in standard sizes and fin spacings. Its fins—like those of all Trufin types—are an integral part of the tube and are unaffected by vibration, thermal shock or temperature variations. Liners can be made to standard condenser tube specifications and tube ends can be furnished with full finned ends or fins stripped to liner size. Stripped ends are provided to permit easy installation into headers for rolling-in or brazing operations.

TUBING PROBLEMS SOLVED BY F. E. S.

For the convenience of its customers, Wolverine Tube maintains a Field Engineering Service staffed with highly trained tubing technicians.

In addition to their own specialized training these men are backed by the experience and knowledge gained by Wolverine during its years of tubing leadership.

Members of the Field Engineering Service are available at all times to help solve problems in design, corrosion, tubing selection—or what have you. Next time you have a problem ask for a Wolverine Field Service Engineer—there is no obligation.

SEND FOR FREE BOOK

Valuable information concerning the various types of Wolverine Trufin available—their construction features, alloys and size ranges as well as the applications where each can be used to full advantage is contained in the Trufin Catalog. Write—TODAY for FREE copy.

Use Spreads:

Heat Transfer Revolution caused by Wolverine Trufin®

BY ERNEST DODD

Nowadays being called a revolutionary is almost fighting talk. Except—that is—when the term is used to describe Wolverine Trufin—the integrally finned condenser tube. Trufin is responsible for the technical revolution now underway in the field of heat transfer operations.

From coast to coast and from the Canadian border to the Rio Grande, more and more refineries and processing plants—as well as original equipment manufacturers—are specifying Wolverine Trufin, in its various forms, for use in both new and existing heat exchangers and condensers.

An excellent example of this is to be found in the air-cooled heat exchangers manufactured for major refineries by one of the nation's leading fabricating companies. This company's air-cooled units are designed around Wolverine Trufin Type L/C—a two-purpose tubing composed of an outer tube of high-finned lightweight aluminum mechanically bonded to a liner tube of any desired metal.

By using Trufin Type L/C, the fabricating engineers kill two birds with one stone . . . step up BTU transfer . . . and combat corrosion by specifying an inner liner of any needed metal or alloy.

Still another well-known fabricating company recently completed an order in which the units were also designed around Wolverine Trufin. This time, however, the tubing used was Wolverine Trufin Type S/T (for shell and tube use) and the exchangers were fuel oil heaters designed to speed up oil flow at a large tank farm. In this case, with steam in the tubes and fuel oil in the shell, the oil is in at 100°F and out at 125°F—for a completely successful operation.

And so from here, there, and everywhere around the country—come stories of how Wolverine Trufin—and its integral fins helps engineers improve heat transfer performance. If your company hasn't as yet tried this outstanding tube why not use it next time you retube existing equipment or design new units.

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
CALUMET & HECLA OF CANADA LIMITED
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WOLVERINE TUBE

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Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA.
SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

Wolverine Trufin is available in Canada through the Unifin Tube Co., London, Ontario.

TUBULAR TIME SAVER

Saving time is important—it is directly reflected in both output and financial earnings.

You can save time—lots of it—by using prefabricated Wolverine U-Bend condenser tubes in either finned (Wolverine Trufin®) or prime surface form.

Wolverine bends condenser tubes to your specifications—ships them in disposable box-type pallets in the exact order of their installation—ready for direct insertion into your heat exchanger or condenser.

In addition to assembly time, you eliminate the transportation, space and handling headaches present when dealing with tubes over 30 feet long. One tube sheet is eliminated and floating head problems are reduced. Rolling in operations are cut in half.

Wolverine prime surface tube U-Bends are available in a wide range of sizes and alloys in copper, copper-base alloys and aluminum. Capacity boosting Trufin U-Bends are available in copper, copper-base alloys, aluminum and electric-welded steel. Complete information is contained in Wolverine's Condenser Tube Catalog. Write today.

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CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

WOLVERINE TUBE

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CIRCLE code numbers for more information. (This December issue card expires Feb. 1, 1958.)

2	61	94	131	180B	200B	233	322b	350	370	385	441	446B	448C	453G	456H	462B	468B
6-7	62	95	132	180C	200C	234	322c	L351	371	386	442	446C	448D	454	457	462C	468C
8	63	96	133	180D	200D	236	322d	R351	372	387	443	446D	448E	454A	457A	462D	468D
9	64	97	134	180E	200E	281	323	352	373	388	444A	446E	448F	454B	457B	L463	468E
10	65	98	135	181	201	281a	323a	353	374	390	444B	446F	449	454C	457C	R463	468F
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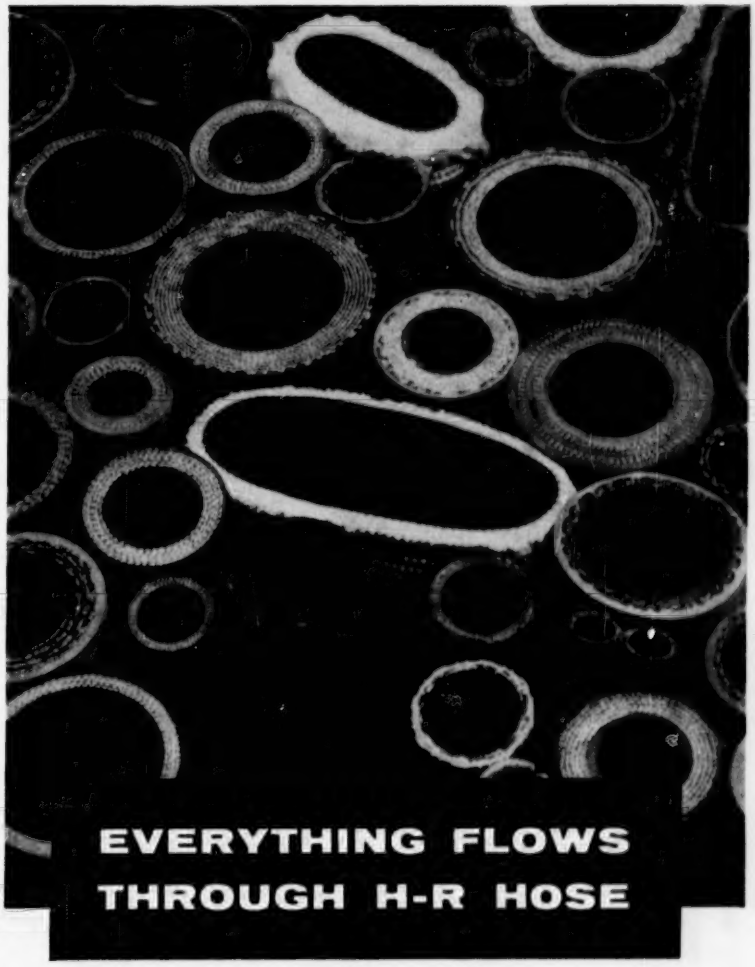

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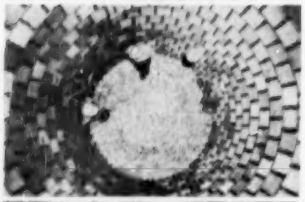

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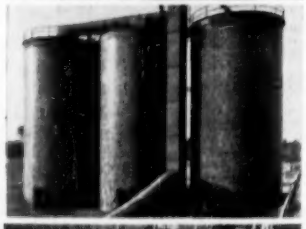

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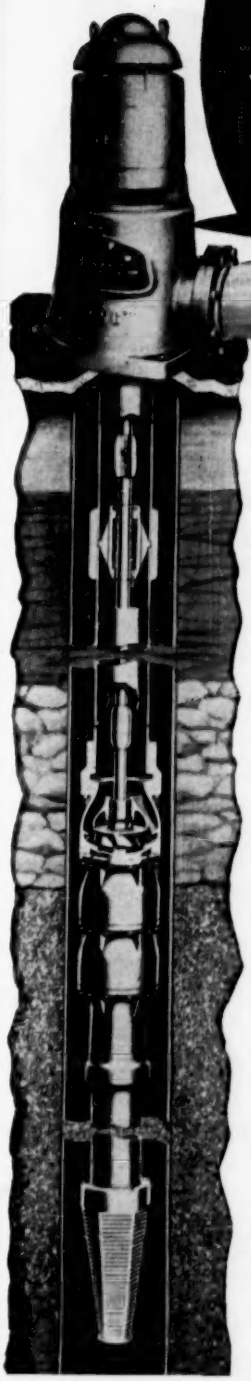

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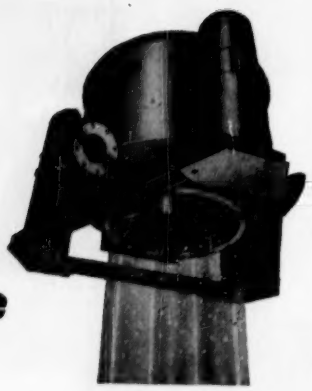

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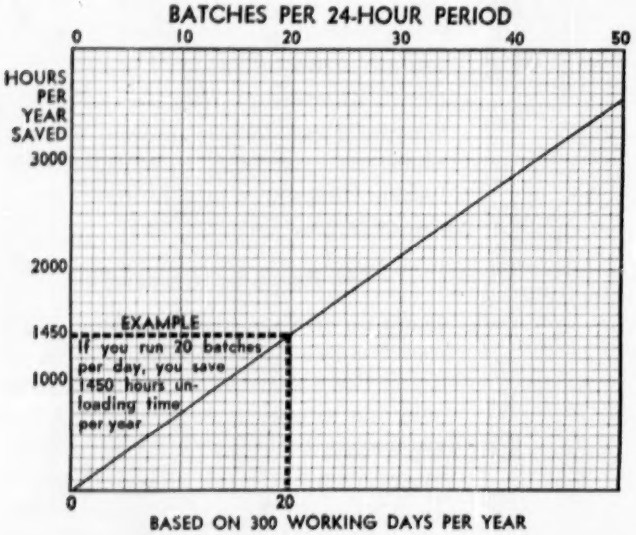

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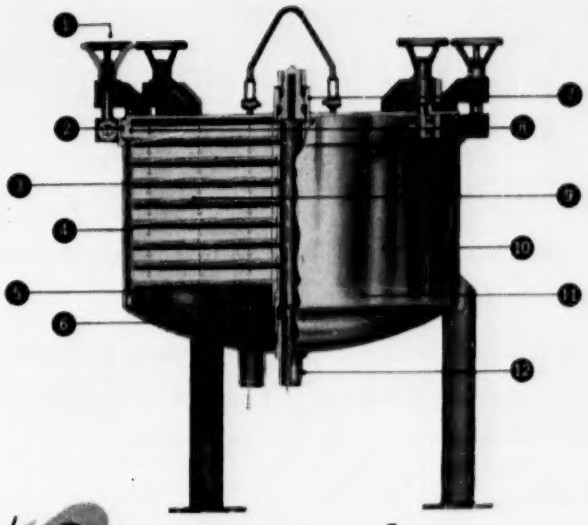

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Acids, Fatty.....“New Slide Guide to Modern Fatty Acids” provides a handy cardboard device for picking out properties of any one of company's acid line. Introduces 16 new products.
444A Wilson-Martin.

Acids, Fatty.....Specifications and compositions of over 180 different fatty acids, fatty acid derivatives and industrial oils are described in a new 8 p. catalog. Lists typical applications.
444B Armour & Co.

Adhesive.....Technical data report R-101, 16 p., describes new Eastman 910 adhesive, outstanding for strength and speed of set. Tabular data covers setting times, tensile properties, etc., for various bonds.
444C Eastman Chem. Prod. Inc.

Alcohols, Fatty.....Fact sheet shows typical uses for lauryl, cetyl, stearyl, and oleyl alcohols. Special emphasis is placed on their application in chemical synthesis. Request a copy.
444D M. Michel & Co.

Anti-Caking Agents.....Bulletin IPD-8-5, 4 p., describes a series of sodium silico aluminates used to resist caking in foods and chemicals. Series of ultro-fine size materials is called Zeolex.
444E J. M. Huber Corp.

Antifoam.....Data sheet describes properties and uses of antifoam for food processing applications. Specific use is in preventing foaming of alkaline potato peeling solutions.
444F Hodag Chemical Corp.

Antistatic Agent.....12 p. booklet DC-1686, called “Ethylsulfonylethanol,” describes properties and applications of a new solvent, intermediate and antistatic agent of low toxicity.
444G Pennsalt Chemicals.

Buffer Salts.....Buffer salts in disposable packets are now available. Each packet is carefully weighed, has been lot-analyzed for purity. Contents dissolved in water make a buffer solution. TD 1292.
378Bd *U. S. Industrial Chem. Co.

Butadiene.....“Butadiene, Its Present and Potential Uses” is a 48 p. compendium of technical data. Sections on physical and chemical properties, derivatives, specifications, physiological properties.
444H Petro-Tex Chem. Corp.

Carbon 14.....Technical bulletin N-18 gives complete information and prices on company's new line of commonly-used carbon 14 labeled compounds. No AEC license needed for packages to 50 microcuries.
444I Nucleonic Corp. of Amer.

Carbon, Activated.....By simple tests in your own laboratory you can determine the dosage of Darco activated carbon needed to solve your purification problem. Send for a Darcograph and samples.
57 *Atlas Powder Co.

Carbon Dioxide.....Versatile carbon dioxide is used for economical freeze-drying, precipitation of carbonates, helping in the pulverization of materials with low melting point, etc. Booklet.
299 *Liquid Carbonic Div.

Ceramic Binder.....Bulletin No. 303B describes properties and applications of a chemically active ceramic binder which increases green and dry strength, eases extrusion and pressing.
444J W. Va. Pulp & Paper Co.

Chemicals.....New 1957-58 Celanese product index tabulates products, and their properties, alphabetically within use categories. New additions include three acrylates, two epoxy plasticizers.
444K Celanese Corp. of Amer.

Chemicals.....Commercial uses of 100 organic and inorganic chemicals are described in 16 p. manual, S-124. Includes sections of rubber processing chemicals and developmental chemicals.
444L Pennsalt Chemicals Corp.

Coatings.....New bulletin describes a new modified styrene resin for use in gold bronze vehicles. Films which it produces are said to be tough, hard and non-oxidizing. Resin's color resists heat.
444M Penn. Ind. Chem. Corp.

Coating.....New polyindene resin for aluminum is described in new bulletin. Available in flaked, solid or solution form, it is said to provide improved retained leafing, can-stability.
444N Penn. Ind. Chem. Corp.

Cyclohexanol.....32 p. Bulletin I-20 contains 10 p. of physical and chemical properties of cyclohexanol. Describes and illustrates all principal reactions. Suggests uses in coating, plasticizers, other.
444O National Aniline Div.

Elastomers.....Company offers “The Du Pont Elastomers”, a review of properties of neoprene and Hypalon, and “Elastomers Notebook”, which contains articles based on uses of elastomers in industry.
131 *E. I. du Pont de Nemours.

Epoxy Plasticizers.....Technical bulletin No. 3 gives detailed data on properties, performance characteristics and recommended uses for monomeric epoxy plasticizers, Drapex 3.2 and 4.4.
444P Argus Chemical Corp.

Floor Hardener.....4 p. brochure outlines features and advantages of a product used for chemically hardening and dustproofing concrete floors. Chart compares its action with usual hardeners.
444Q L. Sonneborn Sons.

Fluorides.....Write for your free copy of M. C. A. Chemical Safety Data Sheet SD-25 on properties and essential information about hydrofluoric acid, anhydrous and aqueous. High quality.
80 *Harshaw Chem. Co.

Furfural.....There are many possibilities for product development using furfural as a starting raw material, especially in organic synthesis. Company offers a General Survey on QO Furfural.
22-3 *Quaker Oats Co.

Gadolinium Oxide.....Data sheet on gadolinium oxide lists some of its high temperature properties and also some of the properties of gadolinium nitrate solutions.
444R Research Chemicals Inc.

*From advertisement, this issue.

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Glycerine.....Glycerine is hygroscopic, nontoxic, stable, nonvolatile, with excellent solvent power and agreeable taste. Stable in price, dependable in supply. "Glycerine Properties and Uses."
383 *Glycerine Producers' Assn.

Guar Gum.....Properties, uses and actual technical applications of company's guar gum as a selective flocculant, flotation reagent, stabilizers, dispersant, suspending agent.
445A General Mills, Inc.

Guar Gum.....12 p. booklet tells how company's guar gum can be used to improve printing paper quality while reducing mill costs through increased production. Illustrated, two-color presentation.
445B General Mills, Inc.

Guar Gum.....16 p. booklet shows use of company's guar gum in ore concentration when utilized as an auxiliary reagent, settling agent or filtration aid. Basic application techniques are covered.
445C General Mills, Inc.

Isobutyronitrile.....5 p. report includes specifications, properties, and a number of basic reactions such as hydrolysis, reduction, oxidation and formation of amidines, ketones.
445D Eastman Chem. Prod.

Magnesium Oxide.....Magnesium oxide has unusual versatility in performance characteristics and is produced in the highest purities ever available in carload quantities. Magnesium Oxide Brochure.
107 *International Min. & Chem.

Methallyl Alcohol.....5 p. technical bulletin illustrates methallyl alcohol's reactions with sulfuric acid, organic acids, hydrogen, air-silver catalyst, air-copper catalyst and others.
445E Food Mach. & Chem.

Nickel Stripper.....New nickel stripper is reported to contain no cyanide, caustic or acid and to be stable over long periods of time, even at high temperatures. Will not fume or pit. TD 1300.
378B1 *U. S. Industrial Chem. Co.

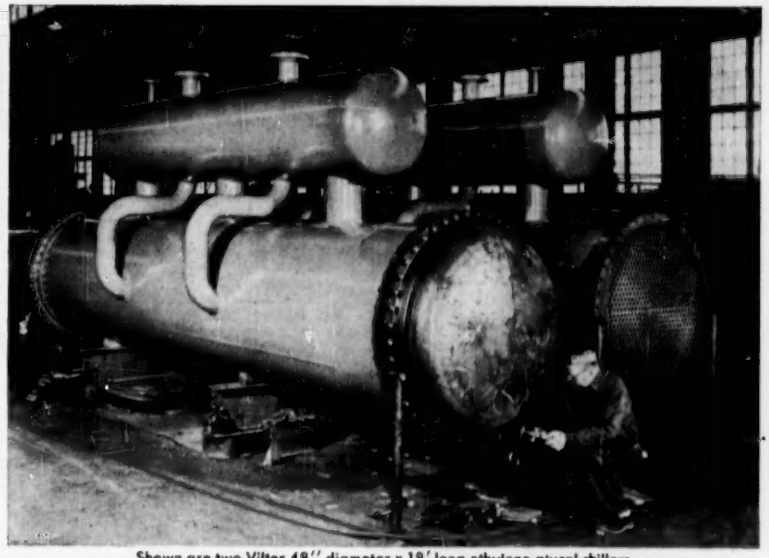
Oleoresin Mace.....Oleoresin mace, a new spice oleoresin, is a dark, reddish-brown, homogeneous liquid said to be completely solvent-free. Contains 50 to 60 cc. of volatile oil per 100 grams. 1299.
378Bk *U. S. Industrial Chem. Co.

Paints, Acrylic.....A 70 p. brochure, "Progress Report Four," gives detailed summaries and tables covering company's findings in an extensive "every-climate" test program on acrylic emulsion paints.
445F Rohm & Haas Co.

Persulfates.....Persulfates offer unusually high oxidation potential, good resistance to catalytic decomposition and other advantages. Company offers Booklets 34, 68, 63 and 86.
197 *Becco Chem. Div.

Plastic Color Concentrates.....16 p. "Tenite Plastics Views" explains how company can accurately impart desired colors to butyrate, acetate and polyethylene. Illustrations show scientific color equipment.
445G Eastman Chemical Products.

*From advertisement, this issue.



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Plasticizer.....Technical bulletin 401 describes properties of new, relatively low cost, low temperature plasticizer. Details advantages in vinyls compared to currently available adipates.
445H Emery Industries.

Plasticizer.....Technical Bulletin No. 2, 5 p., describes an ester type plasticizer which imparts good low temperature characteristics to nitrile rubber compounds in place of or used with other plasticizers.
446A Columbian Carbon Co.

Plasticizer.....8 p. bulletin covers use of company's plasticizer ODN in compounding of acrylonitrile copolymers and of various vinyl resins. Includes up-to-date physical property data.
446B Harwick Standard Chem.

Plasticizers.....Two monomeric ester-type plasticizers are said to be useful for safety glass, synthetic rubbers and lacquers, and as plasticizers for cellulose acetate butyrate, etc. TD 1296.
378Bh *U. S. Industrial Chem. Co.

Polymer, Liquid.....Company's new polysulfide liquid polymer, LP-205, is described in 2 p. bulletin. Gives typical physical properties of the uncured product as well as those of the cured rubber.
446L Thiokol Chemical Corp.

Polyvinylpyrrolidone.....48 p. booklet describes chemical and physical properties and numerous applications in, for example, cosmetics, pharmaceuticals, adhesives, detergents, plastics.
446D General Aniline & Film.

Radioisotopes.....4 p. bulletin tabulates significant properties of thirteen accelerator-produced radioisotopes including aluminum 26, arsenic 73-74, beryllium 7, cobalt 56, 57, 58.
446E Nuclear Science & Eng.

Resin Extender.....Bulletin No. 111 describes uses of Indulin, an extender for phenolic and furan resins. Details on how it improves properties of paper sheet laminates.
446F W. Va. Pulp & Paper Co.

Resins, PVC.....8 p. brochure describes company-developed suspension process for the manufacture of PVC resins. Flow sheet of process accompanies photos of several operating plants.
446G Scientific Design Co.

Resins, Thermoplastic.....6 p. folder gives characteristics and some specific uses for several specialty products. Also included is information on application methods, packaging.
446H Kendall Refining Co.

Scale Remover.....Compound for cleaning carbonate type scale from low pressure boilers and evaporators is described in 2 p. bulletin B10-85. Covers shipping, handling, dosage and feeding.
446I Nat'l. Aluminate Corp.

Silicas.....New silica gels, hydro gels and other synthetic silicas are introduced in this new 4 p. Bulletin MAC. Company's production process for standard or special compounds is described.
446J American Ind. Chem. Co.

Sodium Metasilicate.....Drymet anhydrous sodium metasilicate provides more detergent power per pound and per dollar, more soil-loosening and soil-dispersing action. File Folder.
T470 *Cowles Chem. Co.

Solvent Emulsifier.....Bulletin 1057-2 describes soapless emulsifier, Sole-Mulse B, built for a wide spectrum of hydrocarbon solvents. Used in emulsion degreasers, oil fire control agents.
446K Sole Chemical Corp.

Vinyl Acetate.....16 p. booklet on company's Niacet vinyl acetate monomer has sections on operating procedures, physical properties, specifications, shipping data, applications.
446L Union Carbide Chem. Co.

Vinyl Plastisols.....Preparation and processing of vinyl plastisols are described in a 28 p. bulletin. Curves and charts show how viscosities are affected by compounding. Request a copy.
446M Monsanto Chemical Co.

Zirconia.....New pamphlet on zirconia discusses the history, chemical and physical properties, composition and porosity of the chemical. Included is a refractory comparison chart. TD 1294.
378Bf *U. S. Industrial Chem. Co.

Construction Materials

Alloys, Aluminum & Magnesium.....New Catalog 57 lists physical properties and conforming specifications for Mg and Al alloys. Includes alloys for sand castings and permanent mold.
Wellman Bronze & Aluminum Co.
446N

Aluminum.....New technical brochure features mill products in aluminum, titanium and other metals in full range of shapes, sizes, and alloys; latest product applications and alloy properties.
446O Harvey Aluminum.

Castings, Centrifugal.....If your product calls for hollow, cylindrical parts up to 33 ft. long or up to 54-in. dia., centrifugal castings are
Sandusky Foundry & Mach. Co.
446P

Castings, Stainless.....28-page booklet gives valuable and complete data on stainless steel castings, including analyses, properties, technical data on handling and heat treatment.
390 *Allegheny Ludlum Steel Corp.

Coating, Protective.....4 p. fully illustrated brochure covers Form-Saver, a quick-drying protective coating with durable, smooth finish for plywood form panels. Step-by-step illustrations of use.
446Q L. Sonneborn Sons.

Electrodes, Welding.....Handy 24-p. guide makes it easy to select electrode best suited for any welding equipment; identified by AWS grade, color coding, chemical and physical analysis.
446R Metal & Thermit Corp.

Fabrication.....Almost any type of heavy processing equipment is readily constructed at 225 acre plant with huge fabricating and machine shops, foundries, forge

*From advertisement, this issue.

and die shops, etc. Booklet.
216 *Newport News Shipbuilding.

Fabrication.....This company recently built two 60-in. rotary disk contactors, the largest in the world. Both are over 60 ft. tall. Illustrated Weldment Bulletin 7001 is available to you.
226 *Baldwin-Lima-Hamilton.

Grating, Steel.....Electroforged steel grating for walkways, stair treads and floors is fabricated to your specifications to meet your own operating requirements. Bulletin 2527 contains data.
70 *Blaw-Knox Co.

Insulation, Pipe.....Free 40-page Booklet F76-312 has exclusive "J" Factor Tables for easy, scientific selection according to cost of fuel, hours of operation, life expectancy, pipe size, etc.
368 *Union Asbestos & Rubber.

Linings, Protective.....Fairprene prevulcanized protective lining material offers outstanding resistance to harsh chemicals, ozone, oxidation, aging and abrasion. Booklet available.
415 *E. I. du Pont de Nemours.

Linings, Tank.....Specially compounded acid-proof rubber tank linings are made from thick, multiple calendered sheets of natural or synthetic rubber to meet your requirements. Catalog 7115.
388 *Raybestos-Manhattan Inc.

Refractories.....Exceptional resistance to abrasion, whether caused by tiny gas-borne particles or sliding steel billets, is a useful property of several refractories. Refractories Magazine and Bul.
223 *Carborundum Co.

Refractories.....Refractory tubes and cylinders featured in 8-p. booklet. Carborundum tubular refractories can be obtained in a wide variety of sizes and shapes. Request copy.
447A Carborundum Co.

Rubber, Silicone Sponge.....Properties of Cohrlastic R-10470 Silicone Sponge rubber sheet for —100 F. to 480 F. applications are detailed in new 2 p. data sheet.
447B Connecticut Hard Rubber.

Steel, Stainless.....New valuable chart lists Government specifications for stainless steels. Shows chemical analysis required for most frequently used military and Federal stocks.
447C Peter A. Frasse & Co.

Steels, Stainless.....Stainless steel resists corrosion, prevents contamination, cleans easily, withstands temperature extremes, provides great structural strength and resists wear. 44-p. book.
59 *Crucible Steel Co. of Amer.

Talide Metal.....Talide metal, has abrasion resistance up to 100 times that of steel, compression strength greater than all metals and alloys, high resistance to deformation. Cat. 56-G.
112 *Metal Carbides Corp.

Tank Construction.....New folder shows several typical applications of Dallas Custom Fabrication and describes facilities of the Custom Division. Complete engineering service offered.
447D Dallas Tank Co.

Tape, Insulating.....New self-adhering polyurethane-foam tape described in new literature. Resists weather and chemicals while sealing against dust, draft, odor and vibration.
447E United Mineral & Chem. Corp.

Titanium ..... Titanium combines unique corrosion resistance with high strength-weight ratio and works equally as well in valves and pipes, as in complex components. "New Heat on Titanium".
15 *Electro Metallurgical Co.

Titanium.....Titanium is available now for long service life, corrosion resistance and economy in use. Corrosion and cavitation resistant, light in weight, strong. Booklet on properties.
26-7 *E. I. du Pont de Nemours.

Titanium.....Titanium is corrosion resistant, as strong as steel, yet 44% lighter. It is a practical way to extend service life by as much as 10, 20, even 50 times. Rem-Cru Review.
213 *Rem-Cru Titanium Co.

Weld Caps.....Folder WC-1 has been revised to cover new sizes and materials for weld caps to be used in pipelines, headers or pressure vessels. Request a copy.
447F Henry Vogt Machine Co.

Welding Data.....Free 180-p. 1958 edition of Welding Data Book featuring simplified welding procedures for every base metal is now available. Also covers rods, electrodes and compounds.
447G Eutectic Welding Alloys Corp.

Electrical & Mechanical

Belts, Power Transmission.....New concept in transmission belts eliminates stretch; extreme strength of polymer section permits thin belt to run at much greater speeds than other belts.
447H Extremultus Inc.

Cable, Cathodic Protection.....Bulletin RCP 1110 shows how underground pipelines and other buried metallic structures can be protected from corrosion by using cathodic cable.
447I Rome Cable Corp.

Chains, Roller.....Ny-Steel flat-top roller chain has a smooth, resilient nylon carrying surface to reduce glass breakage and track wear, plus a precision steel roller chain. Folder 2492.
99 *Link-Belt Co.

Couplings, Geared.....Booklet 2775 describes company's complete line of improved geared flexible couplings. Bores range up to 7 in. and ratings from 2½ to 572 hp. per 100 rpm.
447J Link-Belt Co.

Gaskets.....Safe, positive sealing at highest temperatures and pressures and under lighter bolt loads is assured with Guardian gaskets. You can vary the compressibility for different loads. Cat. AD-104.
221 *Garlock Packing Co.

PENFLEX TUBING

ADDS LEAKPROOF FLEXIBILITY

TO RIGID TANK LINES

Moving slowly with expansion, contraction and settling of storage tanks or riding out the tide in unloading tankers, Penflex Tubing has proved its flexibility. It "gives" with temperature changes and settling without breaking . . . withstands crushing, abrasion, exposure . . . yet it stays as tight as a pipe, prevents dangerous leaks and seepage.

Whatever your tubing needs—for oil field, refinery, bulk plant, transportation equipment—let Penflex meet them with *flexible*, corrugated or interlocked tubing available in bronze, galvanized or stainless steel tubing in sizes from ⅛" to 24" I.D. For full data write Pennsylvania Flexible Metallic Tubing Company, Inc., 7234 Powers Lane, Phila. 42.

GET YOUR COPY of this practical, helpful guide to flexible tubing.

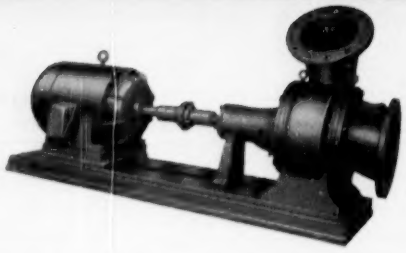
PENFLEX

TIGHT AS A PIPE BUT... FLEXIBLE

*From advertisement, this issue.

Fig. 3135 single-stage paper stock pump. Centerline discharge and self-venting casing provide steady flow without binding. Non-clogging impeller with back wall ejector vanes. Handles slurries. Twelve sizes; capacities to 6400 GPM, heads to 215 ft.

Fig. 3138-39. Specially designed for heavy duty service, pumping corrosive or noncorrosive liquids, with or without solids in suspension. Vertically split casing, "back pull-out" design. Four sizes; capacities to 9000 GPM, heads to 160 ft.



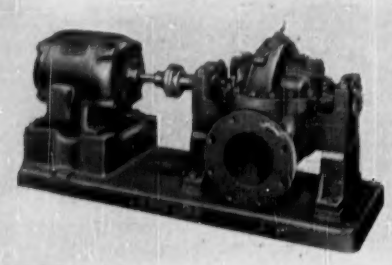


Fig. 3405 single-stage, double-suction pump. All sizes and pump combinations based on only 3 shaft and bearing assemblies. Mechanical seals or stuffing boxes. Rotation can be changed in field. Thirty-three sizes; capacities to 6400 GPM, heads to 425 ft.

GET QUICK ANSWERS TO CORROSIVE PUMPING PROBLEMS

You can solve corrosive pumping problems quickly because a number of Goulds centrifugal pumps now come in a wide range of special metals.

You can get them with fluid ends in your choice of the special metals listed below. Just match the special metal to your pumping problem.

All Bronze
Type 2 Ni-resist
All Iron
Bronze Fitted
Nickel Aluminum Bronze
Steel and Steel Alloys

What's more, you'll get prompt delivery on these pumps (or any of four other types) in corrosion-resistant constructions from Goulds foundries.

You can keep spare parts inventory low, and meet quick changes in process requirements because Goulds pumps are designed with standardized parts for easy interchange between sizes.

Bulletin 5252-J has brief descriptions of these pumps (and the Goulds-Pfaudler *glassed* pump). Write for a copy.

GOULDS

PUMPS FOR THE PULP AND PAPER INDUSTRY

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NEW YORK CITY, Room 1503, 11 Park Place
PHILADELPHIA, 2099 North 63rd St.
PITTSBURGH, Room 512 Bessemer Bldg., 104-6th St.
TULSA, 543 East Apache St., P. O. Box 6157

West Coast Representative: GOULDS PUMPS Western, Inc., 1919 N.W. Thurman St., Portland 9, Oregon
In Canada: The A. R. Williams Machinery Co., Ltd. ... in all principal cities

LITERATURE . . .

Gaskets.....Jacketed gaskets of compressed asbestos and woven asbestos in Type 1 Teflon envelope, gaskets with neoprene filler and Type 2 Teflon envelope, and reducers described in Catalog AD-154.
327 *U. S. Gasket Co.

Lights, Indicator.....New indicator lights shown in brochure L-159 incorporate tiny GE Neon Glow Lamp NE-2D. Lights, shown with dome lenses, are available for front or back mounting.
448A Dialight Corp.

Light, Pilot.....New design features a separate circuit to test the bulb; simply push the bulb into test position by depressing color cap. Unit is oil-tight, no wires to be broken.
448B Square D Co.

Motors, Explosion-Proof ..... Company's explosion-proof chemical motors have cast iron housings, stainless steel motor shrouds, bronze fans. Insulation withstands acids, alkali, moisture. Bul. 1050.
58 *Louis Allis Co.

Motors, Vertical Shaft.....Open drip-proof motors are for shallow- and deep-well turbine pump applications. Bulletin 2050 illustrates climatized enclosure giving full weather protection.
448C Louis Allis Co.

Motors, Weather Protected.....Newly designed line of weather protected motors have removable air ducts, removable stator assembly, split sleeve bearings. Bulletins 51B8606A and 05B7894.
86 *Allis-Chalmers Mfg. Co.

Packings.....Unlimited selection of types, shapes and sizes of packings for practically every requirement, for valves, automatic regulators, pumps, agitators and mixers. Bulletin P-325.
347 *Crane Packing Co.

Power Reactors.....Bulletin F-8383 is an application guide for use of saturable power reactors; control a.c. power to furnaces, heaters and other equipment supplying resistive loads.
448D Barber-Colman Co.

Rings, Pall.....Tower volume can be reduced substantially by using metal pall rings in place of metal Raschig rings. Available in 1", 1½" and 2" sizes in various metals. Bulletin TP-54.
136 *U. S. Stoneware Co.

Rivets, High Temperature.....Technical data sheet covers use of rivets and bolts of new super alloys for high temperature applications; jet engines, airframes and missiles are mentioned.
448E Techalloy Co.

Seals, Mechanical.....Patented wedge-lock design automatically seats the seal stator in the stuffing box in perfect face-to-face alignment with the seal rotor on the shaft. Bulletins CP551 & 575.
R467 *Chemical & Power Products.

Speed Reducers.....164 standard sizes of double-reduction speed reducers in ratios ranging from 75:1 to 4900:1 are completely described in Catalog CD-230. Specifications for easy selection.
448F Denham & Co.

*From advertisement, this issue.

Joint, Swivel.....Named Discpak, new swivel joint is designed specifically for steam and hot gas service. Design allows packing units to be replaced without removing joint from line.
449A Chiksan Co.

Turbines, Steam.....Where low steam consumption is important, turbines can be furnished with wide bucket "L" type wheel. Range from 150 hp down to fractional, in six frame sizes. Bulletin 135.
77 *Coppus Eng. Corp.

Unions.....A 16-page handbook, "What Makes a Good Union", tell the important things you need to know about unions. An excellent text book for training new men. Request your free copy.
349 *Clayton Mark & Co.

Welding Fittings.....Company's welding fittings are found on unusual and critical as well as routine jobs because of exceptional quality maintained by rigid standards of manufacture. Catalog 54.
375 *Midwest Piping Co.

Handling & Packaging

Car Dumpers.....Rotary railroad car dumpers are designed to rotate, dump and return to initial position in just one minute. Car retarder permits safe car spotting by operator. Brochure 957.
370 *Heyl & Patterson Inc.

Containers, Metal.....20-p. brochure describes company's complete line of metal containers and features new Snap-On-Clips that eliminate need for content-designating labels. Request a copy.
449B Sherwin-Williams Co.

Conveyor Components.....Complete line of screw conveyor components includes ball bearing hanger, ball and roller bearing counter-shaft end, double ball bearing trough end, etc. Folder 2489.
17 *Link-Belt Co.

Dispensers.....A calibrated dispenser delivers a specific volume of liquid from 1 cc. to 100 cc. rapidly and repeatedly. Measurement is automatic, said to be accurate to within 1%. TD1295.
378Bg *U. S. Industrial Chem. Co.

Dumper, Skip Hoist.....Handles bags, bulk, drums or odd containers; wherever quantities of free-flowing materials require lifting and dumping into bins or vats, dumper will speed operation.
449C Essex Conveyors.

Ejectors.....Low-cost, compact ejectors simplify handling of fluids, vapors, gases and "hot" materials in AEC operations, chemical and petroleum processing, power and water handling. Catalog 512R.
350 *Penberthy Mfg. Co.

Elevators, Bucket.....Minimize overloading, jamming and plugging with new elevator design. Adjustable slide plate determines amount of material picked up by buckets. Bul. BE-101.
449D Carpco Mfg. Co.

*From advertisement, this issue

Rotary AIRLOCK FEEDERS

for practically EVERY process requirement

For low pressure dust control systems where the pressure differential ranges from 0 to 12″ w.g. Available in 6″, 8″ and 10″ sizes—cast iron construction and rotors equipped with renewable wiper strips; with or without drives.

For higher pressure dust control or pneumatic conveying systems where pressures may range up to 5 to 10 psi. Features life time lubricated sealed ball bearings and special shaft seals for heavy, continuous service. Built in 6″, 8″, 10″ and 12″ sizes; with or without drives.

BLOW-THRU

Ideal for feeding flour or any similar product into pneumatic conveying lines, against pressures up to 15 psi. Built in 8″ and 10″ sizes serving 2″ and 3″ conveying lines respectively. Available with or without drives.

Bulletin P-55 contains complete specifications and data—sent promptly upon request.

PRATER

Foremost Builder of Rotary Airlocks

PRATER PULVERIZER COMPANY

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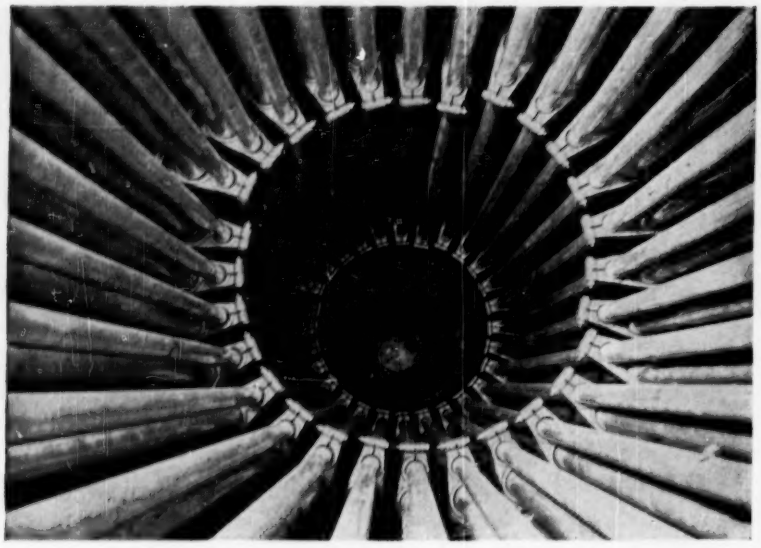
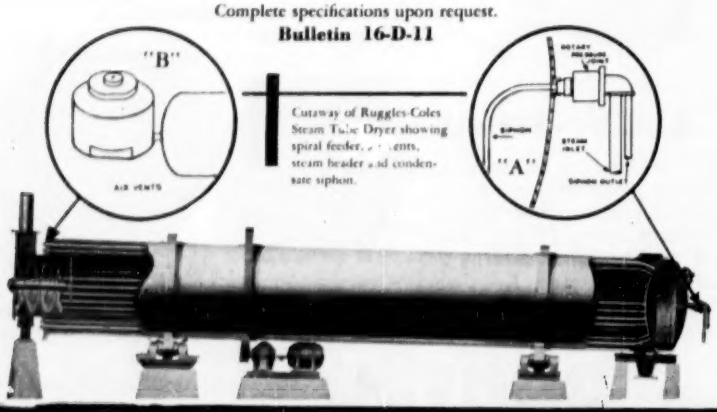


Ruggles-Coles STEAM TUBE DRYERS

- Ruggles-Coles Steam Tube Dryers have been supplied fabricated of aluminum, nickel, monel, inconel, stainless steels and other alloys to provide protection against corrosion and contamination. All fabrication is to code requirements.
- The continuous siphon discharge of condensate is independent of speed of rotation of the shell. (See "A")
- Automatic air vent for each tube eliminates loss of tube heating surface at the feed end of the dryer. (See "B")
- These extra advantages of the Ruggles-Coles Dryer mean continuous maximum output without operating attention and elaborate control devices.

Complete specifications upon request.
Bulletin 16-D-11



Cutaway of Ruggles-Coles Steam Tube Dryer showing spiral feeder, . . . ents, steam header and condensate siphon.

HARDINGE
COMPANY, INCORPORATED

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New York · Toronto · Chicago · Hibbing · Houston · Salt Lake City · San Francisco

LITERATURE . . .

Filling Machine.....Model U-12 Auger Packer packages all kinds of powders and difficult-to-handle products in amounts from 1 oz. to 10 lb. Packing pressure is fully adjustable.
450A Triangle Package Mach. Co.

Holdbacks.....Bulletin 557 is designed to show elevator and conveyor operators the advantages of S-A Holdback in protecting personnel and equipment. Features data and illustrations.
450B Stephens-Adamson Mfg. Co.

Materials Handling.....Packaged presentation contains seven case studies of how several manufacturers solved production, storage and shipping problems with materials handling equipment.
450C Lewis-Shepard Products.

Packaging, Polyethylene.....Polyethylene packaging materials illustrated in a brochure include bags, sheets, drum-liners, pressure-sensitive tape and water vapor-proof wraps. TD 1291.
378Bc *U. S. Industrial Chem. Co.

Packers, Vibrating.....Standardized vibrating packers have container capacities of 350 and 500 lb. They make possible fast, uniform settling of material in boxes, bags, etc. Bul. 63.
450D Ajax Flexible Coupling Co.

Piler, Tonnage.....S-A Swivelpiler handles 140 ton/hr. material; carries it up an 18-in. conveyor to discharge end 35 ft. above ground. Piles material up to 50 ft. in any direction.
450E Stephens-Adamson Mfg .Co.

Scales.....Weight records directly affect, costs, quality, inventory control and customer billing. New Toledo Weight Fact Kit will help you determine how well your scales measure up. **Free.**
374 *Toledo Scale Co.

Shipping Containers, Steel.....Manufacturer's complete line of versatile, nesting, self-palletizing, quickly assembled steel shipping containers detailed in new bulletin. Request copy.
450F Ackermann Co. Mfg.

Tanks, Floating Roof.....Floating roof oil and gasoline storage tanks fabricated and erected by Nooter now have patented seal exerting uniform outward pressure over sealing shoe. Report 4.
163 *Nooter Corp.

Trucks, Lift.....Power Shift torque converter drive is simple to operate and service. With it, you enjoy safety of operation and can position loads quickly with inching control. Bul. BU-465.
289 *Allis-Chalmers Mfg. Co.

V-Belts.....Machines and processes used in production of Goodyear V-belts are described in booklet S-51106. Shows rubber compounding, fabric preparation, building and finishing.
450G Goodyear Tire & Rubber Co.

Weighing System.....Digital, electronic weighing is now possible with new system; applicable for both laboratory and production batch-weighing operations. Literature available.
Performance Measurements Co.
450H

*From advertisement, this issue

Heating & Cooling

Air Conditioning, Controlled Humidity .....Controlled humidity method of air conditioning, using Hygrol moisture-absorbent liquid, is most effective, cleanest, most flexible. Bulletins 112 and 121.
344 *Niagara Blower Co.

Burners.....Combustion is 90% complete within the high velocity burner proper. The burner is completely separate from the liquid being heated and maintenance is simplified. Bulletin 110.
358 *Thermal Research & Eng. Corp.

Desuperheaters, Venturi.....New line of venturi desuperheaters features lighter weight and flexibility in water inlet location. Bulletin 6D gives construction details and sizes available.
451A Schutte & Koerting Co.

Exchangers, Scraped Surface.....Vogt scraped surface heat exchangers are ideal if you have a problem of surface fouling, crystallization, dangerous solvents, etc. Request Bulletin PE-1.
283 *Henry Vogt Mach. Co.

Heat Exchangers.....Bulletin 949 describes company's line of heat exchangers and condensers. General uses and installation sketches of shell-and-tube equipment shown.
451B Pfaudler Co.

Heat Exchangers.....Company offers Bulletin 707 on condensers, brine coolers and heat exchangers and Bulletin 427 on industrial heat exchangers. Company makes all four basic types of exchangers.
445 *Vilter Mfg. Co.

Heat Transfer Equipment.....Aroclor 1248 is a new kind of heat-transfer fluid that's fire-resistant and operates at atmospheric pressure. Company offers list of designers and manufacturers.
95 *Monsanto Chem. Co.

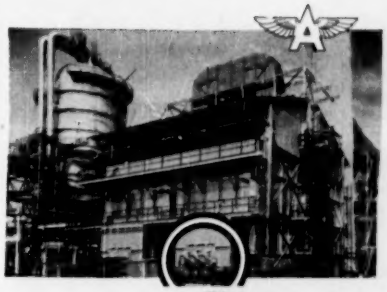
Heat Transfer Units.....A Platecoil is two embossed metal sheets, seam and spotwelded together to form channels for the passage of heating or cooling media. Send for Technical Data Manual P61.
378 *Tranter Mfg. Inc.

Heaters.....Convection air heaters save fuel with automatically correct gas-air ratios, rapid and uniform heating, maximum volume air flow. Also save insulation costs. Literature Group H54-15.
R464 *Surface Combustion Corp.

Heaters.....Grid cast iron steam heat transfer surface ends unit heater maintenance problems, eliminates internal electrolytic corrosion and external corrosion. Request Products Catalog 956 for details.
L466 *D. J. Murray Mfg. Co.

Heaters, Dielectric.....Company's line of dielectric heaters for non-conducting materials extends from a 3-kw unit to 100-kw and larger machines. Complete data is offered in Bulletin 15B6431C.
227 *Allis-Chalmers Mfg. Co.

*From advertisement, this issue.



Firing
CRUDE DISTILLATION UNIT HAVING WORLD'S HIGHEST THRUPUT...

NATIONAL AIROIL

OIL-GAS TANDEM COMBUSTION UNITS

Looming large in the effort to meet increased products demand on the petroleum industry is Tidewater Oil Company's ultra-modern Delaware Refinery, for which C. F. Braun & Co. were the engineers and constructors.

We are proud that this mammoth 130,000 barrel-per-day crude oil Foster Wheeler Corporation heater is fired by NATIONAL AIROIL BURNERS... Why?... because NATIONAL AIROIL "Hi-Visk Airocool" Tandem Units are *more* than just combustion equipment. They are an *exclusive* Combustion System which has *proved* dependable in Petroleum Refineries throughout the world.

"Hi-Visk Airocool" Tandem Combustion Units (firing refinery gases, liquid asphalt, refinery fuel oils) hold heated combustion air within the high temperature zone until fuels and air are thoroughly mixed. This means that combustion takes place under the best conditions; the result: increased fuel efficiency with a minimum of excess air.

NATIONAL AIROIL Tandem Units provide extra flame travel *without adding to the furnace depth*, eliminating flame impingement on walls and tubes, extending the life of those elements; and because of this added flame length, the heat is more uniformly distributed.

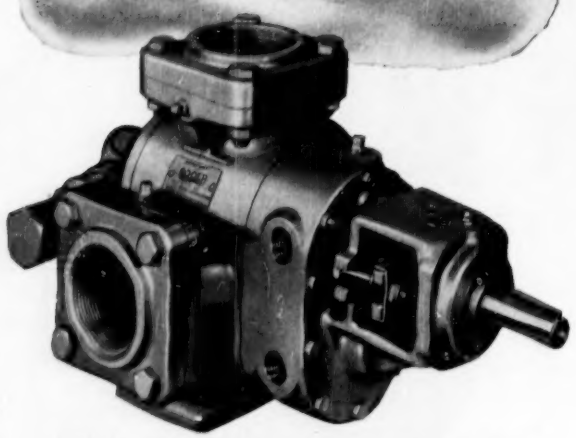
The Tandem Unit is popularly fired with NATIONAL AIROIL Combination Oil and Gas Burners. YOU will realize higher profits from YOUR heaters when Tandem Combustion Units are specified. Further information sent upon request on your business letterhead.

CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER CO., INC.

Main Office & Factory: 1234 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas
INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

NEW ROPER PUMP WITH STEAM CHEST



LOW COST METHOD OF HEAT TRANSFER TO PUMP AND PACKING

Capacities from 27 to 223 GPM

Pressures Up to 100 PSI

This is the same Roper Series 3600 Pump as found in general transfer installations, but with the added feature of a steam chest. A rotary gear unit, it is available with or without relief valve . . . also furnished with gear reduction, if desired.

TWO TYPES OF CONSTRUCTION:

Spec. 3878 Fitted with Bronze Bearings
Spec. 4049 All Iron Construction
All Units Fitted with Aluminum Gaskets and High Temperature Packing

Steam Chest: Located between case and outboard bearing to transfer heat to both pump and packing. A low cost method for handling thick, viscous liquids. Can be used with steam, hot water, or heat transfer oil. Pump and steam chest static tested at 300 PSI. Recommended pressure with steam is 125 PSI.

- **Four ports in steam chest for installation convenience.**
- **Hardened gears and shaft precision ground; steel shaft induction hardened.**
- **Equipped with high temperature packing (600° F. max.) for effective sealing and long life. Pump fitted with aluminum gaskets.**

Send for Bulletin No. 29

ROPER HYDRAULICS, INC.
formerly
Geo. D. Roper Corp., Pump Division
462 Blackhawk Park Ave.
Rockford, Illinois

ROPER *Rotary Pumps*

LITERATURE . . .

Heaters, Gradiation.....The uniformity of Gradiation heating, along and around the multiple coils, helps extend tube life. Instant response to controller demand. Request Bulletin 1012.
132 *Selas Corp. of Amer.

Kettles, Reaction.....New kettle system for processing resins and plastics contains radiant-heated kettle equipped with a stainless-steel direct-fired furnace for close temperature control.
452A Blaw-Knox Co.

Kiln, Rotary.....New concept in rotary kiln design simplifies foundation plan, avoids frictional wear, reduces torque and power load and saves maintenance costs. Request literature.
452B Vulcan Iron Works.

Ovens.....An exacting testing and production oven that provides very close heat uniformity. Built-in indicating temperature controls. Six sizes and types are available. Bulletin 107.
T472 *Despatch Oven Co.

Thermo-Panels.....Thermo-Panel coils give direct heating, which is much more efficient than old-fashioned outside heating with pipe coils, steam jackets, electric heating, etc. Request Bulletins 355 and 257 now.
L469 *Dean Products Co.

Traps, Steam.....Company's steam traps discharge condensate and air from steam lines and equipment faster than any other trap of comparable size, using a large orifice effectively. Bul. 1055.
92 *W. H. Nicholson & Co.

Traps, Steam.....Yarway Impulse steam traps, using the thermodynamic principle, have only one moving part, a small stainless steel valve. "The Why and How of Steam Trapping" is offered.
399 *Yarnall-Waring Co.

Traps, Steam.....Armstrong Steam Trap Book, 44 pages, gives information about the safety factors essential to operating efficiency. It contains completely reliable data for any trapping job.
391 *Armstrong Machine Works.

Vaporizers.....Foster Wheeler does complete job of designing and building a vaporizer using Dowtherm, installing it in the plant, putting it on stream and making sure it works. Bul. ID-54-5.
157 *Foster Wheeler Corp.

Instruments & Controls

Analyzers, Gas.....Chromomax gas chromatography analyzer gives a picture of process streams containing natural gases, vapors, low boiling point liquids or hydrocarbons. Folder ND46-91(7).
317 *Leeds & Northrup Co.

Analyzers, Gas.....New 24-p. brochure describes two gas chromatography instruments; single-stage vapor fractometer and triple-stage vapor fractometer—analyzes sample with wide boiling range.
452C Perkin-Elmer Corp.

*From advertisement, this issue

Calibrator.....Type C calibrator is an instrument for calibrating wire strain gages, transducers and thermocouples; utilizes advanced circuitry to provide versatile, dependable tool.
453A Allegany Instrument Co.

Computer.....Model 610 auto-point computer is a mobile, flexible desk-side calculator possessing logical and arithmetic facilities normally found only in large computers.
453B International Business Machines.

Computers.....Tape entry to computers is facilitated by a machine which gathers asynchronous digital information from external sources and combines it with data in sequence. TD1293.
378Be *U. S. Industrial Chem. Co.

Computer Use.....Copies of an article entitled "Analog-to-Digital Conversion" are now available. Various types of analog to digital converters are discussed and examples given.
453C Beckman Instruments.

Computer Use.....Reprint of an article entitled "Computers in the Process Industries" by William Gunning now available. Describes aspects of data acquisition, processing and reliability.
453D Beckman Instruments.

Control Systems, Supervisory..... Transistorized audio-tone transmission units save 95% power and 50% space over conventional units. Design features and characteristics outlined in Bul. 240-P4.
453E Builders-Providence.

Controllers, Electronic..... Transistorized electronic controllers are interchangeable at the panelboard for versatility. Controller settings are calibrated and repeatable. Bul. RC100.
98 *Manning, Maxwell & Moore.

Controller, Gravity.....Control density and gravity of any process material passing through a pipe. No part of equipment comes in contact with process materials. Request Bulletin JSP.
453F Instruments Inc.

Controllers, Valve.....Type SA valve operators featured in Bulletin 4-57 have pre-set compensating springs which assure tight valve seat. Can be field-mounted on any size valve.
453G Philadelphia Gear Works.

*From advertisement, this issue

For the latest developments in

Chemicals
Equipment
Processes

you'll find our "Guide To Technical Literature" right up your alley. You can get any bulletin or catalog in this listing . . . and fast. Simply circle the item's number on the Reader Service Post Card and mail.

GOODYEAR'S NEW CHEMIGUM PLANT EQUIPPED WITH FRICK REFRIGERATION

This versatile plant, just completed at Akron, makes many types of rubber, latices and plastics. The big reactors, each holding 3000 gallons, are lined with glass; each is cooled with seven banks of glass-coated ammonia coils of the patented Frick direct-expansion design.

Cooling coils for reactors being welded in the Frick shops

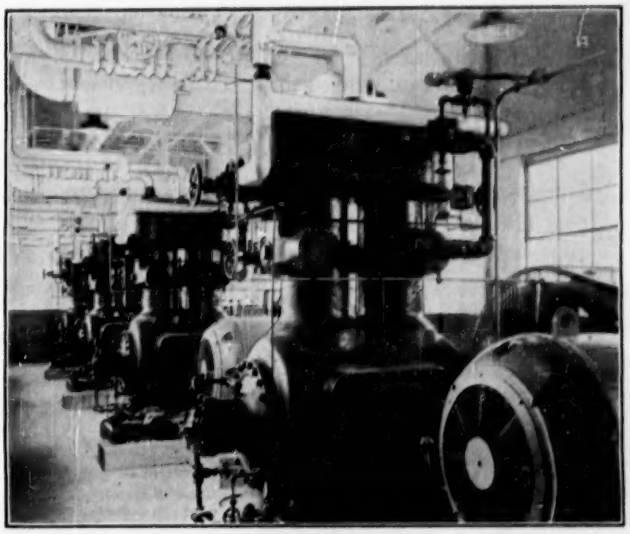
These coils, with their control system, enjoy a world-wide preference for use in chemical reactors.

Four Frick compressors of 12 in. bore and 12 in. stroke, together with a 5 by 5 machine, carry the refrigerating load under automatic and semi-automatic controls.

When you want the most durable and efficient refrigerating equipment, whether for air conditioning, process work, ice making, quick freezing or other cooling service, specify "Frick." Literature and estimates on request.

See our exhibit in Booths 1258-60 at the Exposition of Chemical Industries, New York Coliseum Dec. 2-6.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA., U. S. A.



Frick ammonia compressors at Goodyear's new plant in Akron, Ohio

IMPULSE RUNNER

DURALOY

It's a 7 ton 18-8 Casting designed to handle acidulous water

With our battery of large electric furnaces and our large modern well equipped molding department, castings of this size are quite common in our production schedule.

Yet, if you require it, we can produce castings as light as only a few ounces. In fact, with our shell molding department we can produce in quantity very small pieces of any high alloy analysis desired.

Experience? Well, our work with static high alloy castings goes back to 1922 and with centrifugal castings back to 1931. This long experience is your assurance of a sound casting correctly alloyed.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

LITERATURE . . .

Control, Level.....Roto-Bin-Dicator, bulk material level control device, has been improved. Permits use where severe operating conditions may exist. Bulletin 8C gives construction details.
454A Bin-Dicator Co.

Controls, Photoelectric . . . . . Protect property against intruders; electric-eye system has invisible infared beam that operates up to 1,000 ft. Also use for general control. Bul. PA 579.
454B Electronics Corp. of Amer.

Controls, Pressure.....New flexible series of pressure controllers introduced; can be converted in field to four different-acting instruments. Full information in Bulletin D-4150.
454C Biddle Co.

Data Reader.....Model R-1 is an all-new inexpensive oscillogram reader; handles any number of linear or non-linear channels, correcting for linear or non-linear scale factors.
454D
Gerber Scientific Instrument Co.

Digital Comparator.....Bulletin 418 describes advanced digital comparator: numeric, transistorized design, works with standard servo components, flexible in use and range.
454E Norden-Ketay Corp.

Gages, High Vacuum.....Broad line of high vacuum gages described in Bulletin 9-1. There's an instrument for every need; one model measures vacuums up to 2 x 10-12 mm. Hg. Request a copy.
454F
Consolidated Electrodynamics Corp.

Gage, Liquid Level.....New magnetic gage is designed for gaging liquids under conditions where glass, gaskets and threads cannot be used because of danger of explosion or fire. Bul. 306.
454H Jerguson Gage & Valve Co.

Gages, Liquid Level.....Catalog 305 is an easy-to-use working tool for the engineer; contains standard and special function gages and valves, gives dimensions and characteristics.
454I Jerguson Gage & Valve Co.

Gage, Liquid Level.....Tank gaging system offers unlimited distance gaging, error-safe metering and accuracy to 1/16 in. with 100-tank capacity. Specify Bulletin M-601.
454J Texas Instruments.

Gages, Pressure.....Solid front Acragages described in Bulletin 364A; refined bourdon gage design. Contains chart listing complete line of gages and full specifications.
454K Norden-Ketay Corp.

Gages, Pressure.....Bulletin 403 illustrates new concept in gage design; Bandrive gages transmit deflection of bourdon tube without gears, gives maximum accuracy and responsiveness.
454L Norden-Ketay Corp.

Gages, Test.....Bulletin M-28 describes new line of test gages featuring 360 degree dial readings. Size range 60-15,000 psi.; calibration accuracy 0.15%; flush, stem or wall mount.
454M Martin-Decker Corp.

*From advertisement, this issue.

Gages, Vacuum.....Data sheet 560 describes new Stokes line of electrical vacuum gages for continuous and accurate measurement of very low absolute pressure. Thermopile principle.
455A F. J. Stokes Corp.

Hygrometer, Portable.....For indicating relative humidity when current is not available, instrument features specially treated plastic sensing element. Details available in Bulletin 103.
455B El-Tronics Inc.

Instruments.....16 p. fully-illustrated bulletin describes a new analyzer for traces of gases in metals. Gases measured are hydrogen, oxygen and nitrogen. Metals include steel, titanium, nickel.
455C Fisher Scientific Co.

Instruments, Industrial.....Complete information on instruments and accessories has been compiled in new 60-p. catalog. Catalog 500 includes specifications, part numbers and prices.
455D Foxboro Co.

Instruments, Miniature.....Tel-O-Set miniature instruments accurately record, indicate and control process variables. Personnel training time is minimized. Send for free Catalog C 1001-1.
30-1 *Minneapolis-Honeywell Reg.

Instruments, Pneumatic.....Line of null-balance-vector pneumatic instruments includes pressure, differential pressure, temperature and control transmitters. Request descriptive folios.
62 *Republic Flow Meters Co.

Instruments, Pressure Sensitive..... New booklet tells how to select company's instruments for following applications: Absolute pressure; gage, vacuum, differential pressure and others.
455E Wallace & Tiernan.

Load Cells.....Advances in hydraulic load cells give these units a smooth performance even under adverse conditions. Compression cells up to 60,000 lb. and tension up to 20,000 lb. Bul. M-27.
455X Martin-Decker Corp.

Meters.....Neptune meters handle over 150 liquids. hot and cold water, syrups, liquid sugars, oils, brines, soap solutions and many chemicals. Sizes range from ⅝ to 6 in. Data Book 566-D.
342 *Neptune Meter Co.

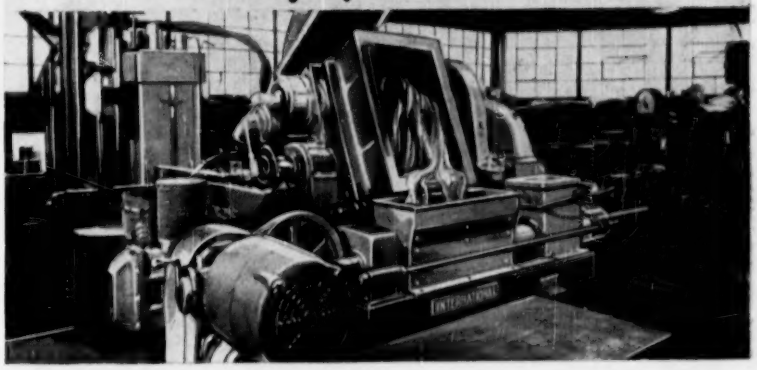
Meter, Flow.....Lightweight, turbine-type flowmeter with accuracy of ½% handles gasoline, oil, water and chemicals at pressures up to 5,000 psi. and temperatures up to 1,000 F. Bul. 1314.
455F George I. Nankervis Co.

Meter, Flow.....The Dall tube, differential-pressure producer, offers these advantages over conventional venturis: Lower head loss, easier installation and lower initial cost. Bulletin 275.
455G George Kent Ltd.

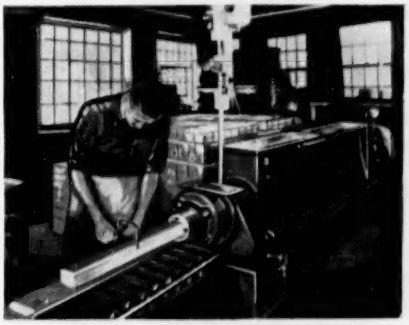
Moisture Monitor..... Instrument gives continuous accurate measurement, remote recording and control of low moisture levels. Ideally suited for air and natural gas lines. Bulletin 1845.
455H
Consolidated Electrodynamics Corp.

*From advertisement, this issue.

INTERNATIONAL
Mixing and Agglomeration Equipment



EXTRUSION MACHINES INTERNATIONAL Vac-Air Extrusion Machines are made in many sizes, from the Vac-Aire "Experimental" or Laboratory model with a 3 inch diameter auger and a capacity of 1500 to 2000 pounds in eight hours, to the Vac-Aire "Eagle" with an 18 inch diameter auger and a capacity of 20 to 30 tons per hour . . . Can be fitted with single speed or variable speed motors—jacketed for steam, oil, or water.

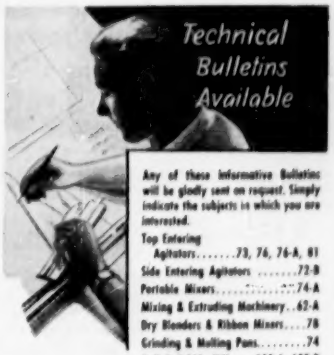


AGGLOMERATION EQUIPMENT

1. Reduces dusting losses and hazards by briquetting and pelletizing—as in carbon black.
2. Forms definite shapes and sizes for catalysts—powder metallurgy—pharmaceuticals.
3. Recovers waste material by nodulizing such as phosphate ores—by briquetting coke and coal fines—by briquetting fine iron and other ores for furnace charging.
4. Increases bulk density of light materials for saving in shipping and storage.
5. Prevents segregation of solid reactants—makes solids free-flowing for extrusion—provides controlled surface volume ratios.

Special Uses

The uses of Vac-Aire De-Airing Machines are legion—they extrude any material that is plastic enough to flow—such as grease sticks—buffing bar material—gypsum blocks—caulking compounds—soaps and detergents—putty—candy bars—meat—white lead—carbon sticks—fuel briquettes—iron ore—chalk—pencils—coal dust—carbide—phosphate—clay—Bentonite—various chemicals, etc. Send for Special new informative Bulletin H 1.



Any of these informative Bulletins will be gladly sent on request. Simply indicate the subjects in which you are interested.

Top Entering Agitators.....73, 76, 76-A, 81
Side Entering Agitators.....72-B
Portable Mixers.....74-A
Mixing & Extruding Machinery..62-A
Dry Blenders & Ribbon Mixers....78
Grinding & Melting Pans.....74
Ball & Pebble Mills....100-A, 100-B
Laboratory & Pilot Plant Equipment.....77-A
Stock Fans & Duct Boosters....109-A
Mixing & Agglomeration Equipment H-1

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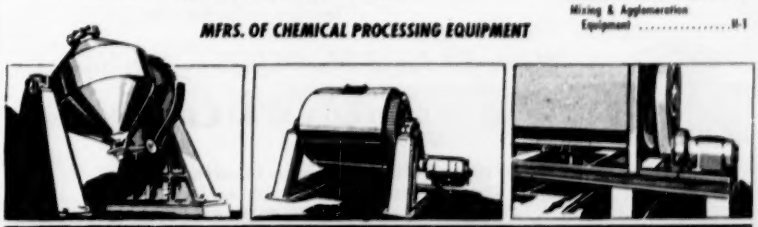
MFRS. OF CHEMICAL PROCESSING EQUIPMENT



CONICAL DRY BLENDERS | PEBBLE AND BALL MILLS | RIBBON MIXERS

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- HIGH TENSILE STRENGTH
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- ABRASION RESISTANT
- CREASE RESISTANT
- CHEMICAL RESISTANT

"NETONE" Filter Paper is a neoprene impregnated kraft paper that offers decided mechanical and chemical advantages over standard filter papers.

When compared to 60-pound unbleached kraft "NETONE" Filter Paper shows a 500% increase in wet tensile strength, wet burst factor increases from 6 to 57 and there is a marked increase in abrasion and crease resistance.

The following are a few test results indicating comparative resistance factors.

Solution	60-Pound Kraft	Wet Strength Resin	Neoprene Treated (3%)
H_2O	0	72 hr.	86 hr.
10% HCl	0	6 min.	4 hr.
10% NaOH	0	6 hr.	72 hr.

Write us about your requirements and we will be glad to send samples for your testing.

. . And for your filter cloth requirements we weave fabrics of treated Cotton, VINCEL†, SARAN, DYNEL, GLASS, DACRON††, TEFLON***, POLYETHYLENE, NYLON, ORLON*, AND POLYMAX†, Samples sent on request.

* TM for duPont Acrylic Fiber
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†† TM for duPont Polyester Fiber

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Oslo, Norway: Nicolai Friis
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LITERATURE . . .

Orifice Fitting.....Kent P Orifice Fitting is suitable for use with existing pipe flanges where these cannot be sprung sufficiently to insert a carrier. Information in Bul. 283.
456A George Kent Ltd.

Program Controller.....Set-point signal for controlling process variable is produced by shape of 6-in. aluminum cam. Inexpensive cam is easily field-cut to desired shape. Bulletin E99-6.
456B Bailey Meter Co.

Proportioners.....Precision proportioners automatically and accurately blend two or more liquids in closed, continuous production. Request 12-page Folder, "Xacto Precision Blending System".
L465 *Bowser Inc.

Pyrometers.....Sturdy, protective case eliminates need of careful handling of precision meter movement in portable use. Direct reading scale face can be read at a distance. Bulletin 4434.
L351 *Illinois Testing Labs.

Pyrometer, Optical.....Lightweight, spark-proof and dust-tight optical pyrometer available in three ranges, reads up to 7,600 F. Complete information contained in Catalog N-33D.
456C Leeds & Northrup Co.

Recorders.....Consotrol recorders and recording control stations have 3-pen recording, angle mounting, plastic indicating tear-off bar for the highest precision and dependability. Bulletin 13-18A.
44-5 *Foxboro Co.

Recorder, Electronic.....Versatile, circular-chart recorder is completely new. Has interchangeable amplifier design—multitude of variables recorded by selecting one of three receiving units.
456D Hays Corp.

Regulators, Temperature.....No. 11 regulator is designed for precise temperature control, self-powered, simplem compact and dependable. Full throttling action without any external power source. Buls.
L338 *Powers Regulator Co.

Specific Gravity Transmitter.....Differential converter transmitter is adaptable to continuous measurement and control of specific gravity of liquids in open vessels. Data sheet 10.14-8.
456E Minneapolis-Honeywell Reg. Co.

Time Punch.....8200 IBM time punch features time and data card punching for direct input into data processing machines; cut-corner sensing mechanism assures correct insertion of card.
456F Intern'tl. Business Machines.

Timer, Recycling.....Closes any electrical circuit for any desired part or percentage of a fixed time cycle; on-time percentage of cycle adjustable from 3% to 97%. Bulletin 79 available.
456G Industrial Timer Corp.

Transducers, Pressure.....New pressure pickup permits accurate measurement of pressures up to 5,000 psi. under unfavorable environmental conditions. Bulletin 1588 has full details.
456H Consolidated Electrodynamics Corps.

*From advertisement, this issue.

Transmitters.....Series 4700 for pressure and 4600 for temperature transmission combine reliable, accurate performance with operational convenience. Bulletin 214 details both lines.
457A Mason-Neilan.

Transmitters Differential Pressure..... Taylor 205T flow and liquid level transmitter never has to be purged of deposited material and never suffers from corrosion. Accurate, sturdy. Bul. 98281.
52-3 *Taylor Instrument Co.

Venturi, Plastic.....Insert-type venturi flow nozzle can meter many corrosive fluids for which metal venturis are unsuitable; non-oxidizing acids, corrosive salts, etc. Bul. 125-P1.
457B Builders-Providence.

Viscometer.....New manual describes construction and operation of Synchro-Lectric viscometer; even untrained personnel can learn to operate the instrument in five minutes. VIM 57.
457C Brookfield Engineering Labs.

Pipe, Fittings, Valves

Actuator, Valve.....Newly designed valve actuator operates on signals from commercially available controllers, remote positioning devices or directly from measuring element. Bul. 38.3.
457D Askania Regulator Co.

Fittings.....Standard for butt-welded carbon steel piping systems covers materials, assembly methods and welding procedures to use for safe, economical and maintenance free piping.
103-4 *Tube Turns.

Fittings.....150 lb. stainless steel fittings, types 304 and 316, resist a wide variety of corrosive services and are ideal for many low temperature operations. Send for informative Bulletin S-3-55.
362 *H. K. Porter Co.

Fittings, High Vacuum.....High vacuum valves, baffles and traps are listed in Bulletin 10-1; gives dimensions, structural features and applications for wide range of vacuum equipment.
457E Consolidated Electrodynamics.

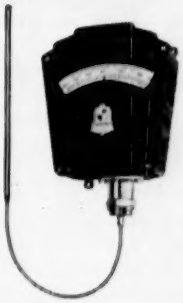
Fittings, Nylon.....Nylon fittings for use with plastic pipe will not corrode, withstand impact blows up to 75 ft.-lb. and have hexagon hub for gripping with ordinary wrenches. Bul. NS600.
457F Franklin Plastics.

Hose, Dacron-Jacketed.....Industrial fire hose jacketed with 100% Dacron is lightweight, compact, abrasion-resistant, resistant to many chemicals, weather and mildew resistant. Booklet.
371 *E. I. du Pont de Nemours.

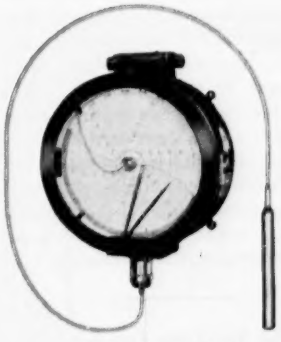
Hose, Flexible Metal.....Flexible metal hose is used to convey almost every conceivable gas and liquid, to absorb vibration, to absorb expansion and contraction in lines. 64-page catalog.
63 *American Brass Co.

*From advertisement, this issue.

DEGREES MEAN DOLLARS



Partlow Temperature Indicating Control



Partlow Temperature Recording Control

Partlow's "pinpoint control" of degrees saves processing dollars

Partlow Controls are protecting materials and equipment in more and more processing operations where maintenance of accurate temperatures is vital.

Available in recording, indicating and non-indicating models, they provide positive, precise temperature control for processes using either gas, oil, steam or water valves, or electrical equipment.

Partlow Controls have a reputation for dependability and long life. Actuated by mercury, they are ruggedly built to withstand shock and vibration without loss of accuracy. Many have been in service for 20 years or more.

Available in ten scale and element ranges, from –30°F. to 1100°F.

Tell your process problems to Partlow. Our Engineers will gladly work with you.

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We are interested in Partlow Controls for the following applications:

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☐ Have representative call. ☐ Send us data on Partlow Controls suitable for applications described above.

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Fansteel
Corrosionomics
REGISTERED U. S. PATENT OFFICE
A JOURNAL OF USEFUL INFORMATION FOR THE SOLUTION OF CORROSION PROBLEMS

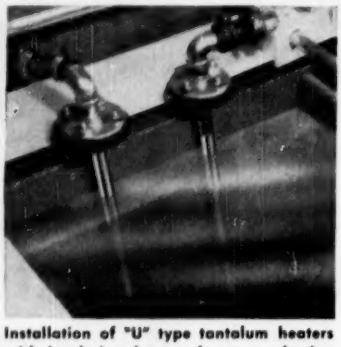
TANTALUM INERT TO ACID PLATING BATHS

The inertness of tantalum to a broad spectrum of acids and oxidizing agents has resulted in increasing usage of this metal for heating and cooling equipment in acid electroplating systems.

Plating baths are heated, usually with steam, at start-up and subsequently must be cooled in most cases during continuous operation. The heat generated by the electric power not consumed in the actual deposition of metal usually is greater than the heat lost by radiation, evaporation, etc., and that used to heat the parts being plated. Coils placed in the plating tank and external heat exchangers thru which the process solution is pumped are the chief types of heating and cooling equipment used. Corrosion is a major factor in the choice of materials for such units.

U-coils and tube and shell heat exchangers made of tantalum are widely applied in the strongly oxidizing chromium plating baths, composed of 33 to 53 ounces per gallon of chromic acid, CrO_3, in dilute H_2SO_4 at a CrO_3/H_2SO_4 ratio of 100/1. They are used with both steam and water to regulate the temperature at the desired value in the range 110°-150°F.

The temperature of the acidic nickel plating baths, containing nickel sulfate and/or nickel chloride at pH's of 0.9-4.8, is controlled similarly with tantalum heating and cooling units. Acid zinc bath temperature regulation



Installation of "U" type tantalum heaters with insulating hoses of non-conducting materials in piping.

Courtesy Metal & Thermit Corporation

likewise can be handled with tantalum equipment. In zinc baths using insoluble anodes the presence of free oxygen discharged at the anode has no effect on tantalum.

Most electropolishing is done in solutions containing a variety of acids, including perchloric, acetic, phosphoric, chromic and mixtures of these and others. With the exception of those containing HF or free SO_3, tantalum is inert to all such solutions over the temperature range used, 110° to 250°F.

In addition to its inertness to acidic solutions, tantalum has several other advantages. Thin wall tubing can be used in the heating and cooling units since no extra thickness need be provided for corrosion loss, no heat-insulating corrosion scale forms on tantalum, no contamination of the plating bath by tantalum is encountered, and space requirements are minimum.

Typical Acidic Plating Baths

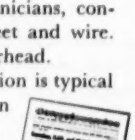
TYPE	REAGENTS*	pH	TEMP.
Chromium	CrO_3, H_2SO_4	< 1	110°-150°F.
Nickel	$NiCl_2$, $NiSO_4$, HBO_3	1-4	90°-160°F.
Zinc	H_2SO_4, $ZnSO_4$	1-4	80°F.
Copper	H_2SO_4, $CuSO_4$	< 1	70°-120°F.

**Tantalum inert to these reagents*

Free Tantalum Test Kit

A corrosion test kit, available without charge to research technicians, contains both tantalum sheet and wire. Request it on your letterhead.

The above condensation is typical of articles which appear in CORROSIONOMICS, a Fansteel publication. Mail us your name for inclusion on our mailing list.



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G576A

LITERATURE . . .

Hose, Industrial.....Facts and figures about chemically resistant, high- and medium-temperature hose and hose assemblies now available in new 12-p. technical brochure. Request copy.
458A Resistoflex Corp.

Joints, Expansion.....Self equalizing universal expansion joints absorb any movement in any direction, axially, laterally, angularly, or any combination of these, to protect equipment. Catalog 56.
215 *Zallea Brothers.

Joints, Swivel.....Discpak swivel joints for steam and hot gas service have new construction allowing packing units to be replaced without removing the joint from the line. Bul. 100.
209 *Chiksan Co.

Nozzles, Spray.....New, full-cone nozzles have been developed for high capacity, low pressure installations where clogging is a problem and full-cone spray pattern necessary. Catalog.
352 *Spray Eng. Co.

Nozzles, Spray.....If the liquid can be sprayed with direct pressure, you can rely on Monarch advanced design spray nozzles to reduce clogging. Used to wax fruits, rinse vegetables, etc. Cat. 1.
L468 *Monarch Mfg. Works.

Nozzles, Spray.....Company offers the most complete industrial spray nozzle catalog ever produced. Gives you reference data on thousands of standard and special spray nozzles. Catalog 24.
T471 *Spraying Systems Co.

Pipe, Aluminum.....Aluminum costs less to buy and install, because of light weight and weldability, resists corrosive effects of many substances. "Corrosion Keys", "Aluminum Process Pipe".
309 *Reynolds Metals Co.

Pipe Benders.....Number 880 hydraulic pipe bender bends pipe or conduit 90 degrees with one ram stroke. Handles ½ in. to 2 in. pipe or conduit. Rugged, lightweight aluminum alloy. Bulletin E-217.
B461 *Greenlee Tool Co.

Pipe Couplings.....Bulletin describes Vic-Easy method of joining thin-wall steel and aluminum pipe and tubing. Provides quick, positive, leak-tight connections.
458B Victaulic Co. of America.

Pipe & Fittings.....The smooth inside surface of rigid, unplasticized polyvinyl chloride pipe and fittings means less trouble with corrosion and internal slime and scale. Bulletin PVC 1200.
L463 *Luzerne Rubber Co.

Pipe, Plastic.....Tough, general-purpose moderately priced rubber-plastic pipe handles most common chemicals to 170 deg. F., except few strong acids and organic solvents. Bulletin 80.
322C *Amer. Hard Rubber Co.

Pipe, Polyethylene.....Ace Parian is odorless, tasteless, rigid polyethylene. Best chemical resistance of any plastic at room temperature except to acetic acid. Bulletin 351.
323b *Amer. Hard Rubber Co.

*From advertisement, this issue.

Pipe, Rubber.....Ace Tempron, heat-resistance nitrile hard rubber pipe, handles inorganics at 250-275 deg. F. and resists wide range of organic chemicals at room temperature. Bul. 96-A.
322a *Amer. Hard Rubber Co.

Tube Stock.....Tube and bar stock information offered in Bulletin 156 details properties of three metals: GC Meehanite, GA Meehanite and Type #1 Ni-Resist; has guide to applications.
459A Shenango Furnace Co.

Tubing, Flexible.....Moving slowly with expansion, contraction and settling of storage tanks, or riding out the tide in unloading tankers, tubing has proved its flexibility. Request Guide.
447 *Penna. Flex. Metallic Tubing.

Tubing, Teflon.....Answer to difficult fluid flow, transfer and insulation problems in chemical processing industry is said to be Teflon tubing. Bulletins 4 and 5 give data.
459B Penna. Fluorocarbon Co.

Valves.....Instant stickproof operation is guaranteed by a built-in lever and screw which mechanically relieves seating pressure. All operating parts are weatherproof. Reference Book 39, Sec. 3
291 *Homestead Valve Mfg. Co.

Valves.....Folder, "Design Factors in Stainless Steel Valves", tells about company's line of valves designed to be cast in stainless steel, with bowed yoke, extra deep stuffing box, etc.
120 *Cooper Alloy Corp.

Valves.....Ni-Resist gate valves have shown a remarkable ability to withstand corrosion and cut valve costs in a wide range of corrosive and erosive services. Request Information Folder 205.
109 *Jenkins Bros.

Valves.....New quick-acting shut-off valve for water, gas or oil service features positive seating by spring and line pressure and 90 degrees turn from full open to close. Bul. 39-8.
459C Homestead Valve Mfg. Co.

Valves, Check.....Chapman tilting disc check valves have no flutter, no vibration, no slamming or jarring or scraping of disc and seat. Fast, sure, quiet operation at all times. Catalog 30-A.
84 *Chapman Valve Mfg. Co.

Valves, Check.....Technocheck is a 100% polyvinyl chloride check valve, resistant to corrosive gases, vapors and fluids. Rugged, versatile and tight sealing. Bulletin Technocheck-PVC.
T476 *Techno Corp.

Valve, Check.....New vacuum-controlled gas-air check valve suitable for gas and air reciprocating compressors is described in Bulletin WH 754. Handles pressures from 125 to 2,500 psi.
459D Williams Gauge Co.

Valves, Cleanout.....Bulletin 4004 describes and illustrates unique safety cleanout valve for removal of water and sludge from bottom of storage tanks. Request details.
459E Petrometer Corp.

*From advertisement, this issue.

your choice of tube expander motor controls . . .
for fast, accurate tube rolling
with **ELLIOTT Tube Expanders**

Expanders available in 4 types for tubes ¾ in. through 3 in.

AIR MAGNETIC CONTROL...

Excellent for precision tube expanding in hazardous locations. Uses new concept of torque control in tube expanding. Two powerful permanent magnets give instantaneous engagement and disengagement between air motor driver and driven expander. Calibrating dial permits exact settings for torque control.

ELECTRIC CONTROL...

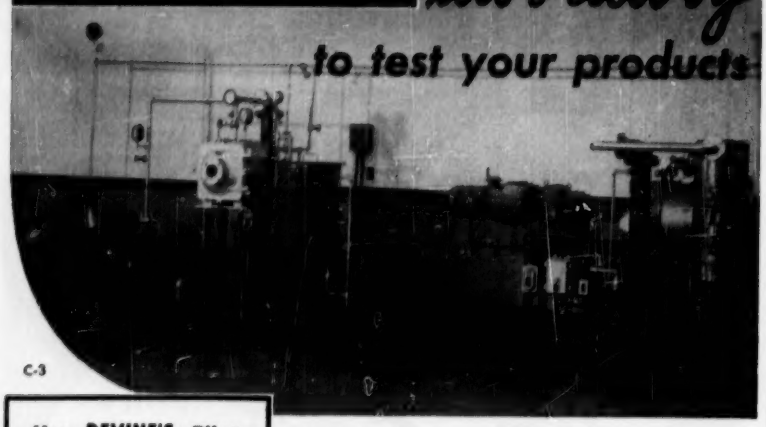
Takes guesswork out of tube rolling. A *torque limiting device,* designed for use with any standard tapping motor. A single setting gives same expansion after metal-to-metal contact for entire rolling operation. *Voltage Balancer* eliminates need for voltage regulator. It's compact and easy to operate.

Y7-7

ELLIOTT Company
Lagonda Division, Springfield, Ohio
Headquarters for Tube Cleaners and Expanders

Devine
PROCESS EQUIPMENT

PROCESS *laboratory*
to test your products



C-3

Use DEVINE'S Pilot-Plant Facilities to establish your exact equipment needs:

- ✓ *Vacuum Drying*
- ✓ *Mixing*
- ✓ *Blending*
- ✓ *Impregnating*
- ✓ *Wood Treatment*

DEVINE invites you to utilize this process-testing laboratory for advance fact-finding in planning production schedules. Let DEVINE engineers help you to determine the type and size equipment your process requires. Your samples—after testing—will be returned to you with written report for your evaluation.

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EASTERN PORTABLE MIXERS

Portable mixers provide the thrifty answer to many mixing problems. Versatile Eastern Mixers can be quickly shifted from task to task to allow one mixer to serve many needs.
Available from 1/20 to 5 H.P. with a variety of speeds and motor enclosures, your small investment in an Eastern Portable quickly pays for itself even if your needs are infrequent and varied.

For complete portable mixer information, write for Eastern Bulletin 520-A.

Eastern INDUSTRIES, INC.
Regent St., E. Norwalk, Conn.

LITERATURE . . .

Valves, Ductile Iron.....Booklet describes advantages of ductile iron and gives specifications on the metal as well as on ductile iron valves in actual use. Get details.
460A Kennedy Valve Mfg. Co.

Valve, Emergency Cut-In.....Cushioned emergency cut-in valve automatically opens to emergency water supply when plant's normal water supply is interrupted. Bulletin W-14 has details.
Golden-Anderson Valve Spec. Co.
460B

Valves, Gate.....Money-saving advantages of the King-Clip gate valve for the most severe 125 and 150 lb. service applications and detailed data are all given in Circular 561.
460C Lunkenheimer Co.

Valves, Pilot.....Valves are available in five basic models—ball cam, palm button, hand lever, locking hand lever and mechanical link clevis. Use for air operation up to 150 psi.
460D Hanna Eng. Works.

Valves, PVC.....Luncor all-molded PVC valves weigh half as much as aluminum, one-sixth as much as bronze, yet high strength-weight ratio gives rigidity comparable to metal. Information Form.
91 *Lunkenheimer Co.

Valves, Regulator.....Bulletin J-SC shows how to size OPW-Jordan sliding-gate regulator valves. Technical data given for sizing applies to all makes of valves. Request your copy.
460E Jordan Corp.

Valves, Stainless Steel.....Folder AD-2080 describes Crane stainless steel valves, ideal for many corrosive services—low cost to maintain and dependable for steady production.
233 *Crane Co.

Valves, Swing Check.....Swing check valve lined with Ace hard rubber for the best in corrosion resistance has large, straight-through flow areas, is non-slamming, sensitive. Bulletin CE-52.
322d *Amer. Hard Rubber Co.

Process Equipment

Agitators & Mixers.....Patented stand-pipe around propeller shaft assures positive agitation and circulation. Heavy duty and acid proof construction are available. Request Bulletin A2-B4.
366a *Denver Equipment Co.

Centrifugals.....AT&M centrifugals are widely used in separation, dehydration, coating, filtering, impregnation and sedimentation processes. New models save space. "Centrifugal Force" Booklet.
305 *Amer. Tool & Machine Co.

*From advertisement, this issue.

Any bulletin or catalog . . . yours for the asking
You can get any publication in this literature listing by circling its key number on the Reader Service Post Card (inside back cover). Replies will reach you direct from the manufacturers.

Crushers, Jaw.....Forced-feed jaw crushers have cast steel frame, manganese jaw and cheek plates. Large diameter shafts reduce shaft deflection and increase life. Bulletin C12-B12.
366d *Denver Equipment Co.

Cyclones.....New 16-p. brochure 830 features installation photos and performance data on many widely diversified applications of Krebs cyclones. 17 models to choose from. Request details.
461A Equipment Engineers.

Dehumidifiers.....For instrument air, Bulletin 857 describes adsorptive-type, automatically regenerated dryers with capacities up to 125 scfm. at 90 F. and 100 psig.
461B Anders-Lykens Corp.

Dryer-Blenders..... Conical dryer-blender produces faster, more thorough drying, more homogeneous blending, both with reduced handling and maintenance. Send for Data Sheet 26 now.
492 *Pfaudler Co.

Dryers.....A Lectrodryer is an adsorbent dryer which makes air, gases and organic liquids truly dry without destructive heating. There is a Lectrodryer for every drying purpose. Bulletin 109.
60 *Pittsburgh Lectrodryer Div.

Dryers.....Standard dryers are available in several types: direct heat, indirect heat and steam tube. No drying problem is too large or too small for Deco engineer. Bulletin D4-B2.
366j *Denver Equipment Co.

Dryers, Steam Tube.....Continuous siphon discharge of condensate in steam tube dryers is independent of speed of rotation of the shell. There is an automatic air vent for each tube. Bulletin 16D-11.
450 *Hardinge Co.

Dryer, Vacuum.....Bulletin 5611-1 details 234-cu. ft. vacuum dryer; handles materials up to 40 lb./cu. ft. and provides fast uniform drying while maintaining high product purity.
Patterson Foundry & Mach. Co.
461C

Dust Collectors.....Literature explains economies of dust control with Torit-designed unitized dust collectors; reduced capital expenditure, operating time and machine operating costs.
461D Torit Mfg. Co.

Dust Collectors.....Exclusive shave-off in Buell Cyclone dust collectors harnesses the double-eddy currents to trap an extra percentage of dust. "The Collection & Recovery of Industrial Dusts."
382 *Buell Eng. Co.

Dust Collectors.....Pangborn dust collectors trap dust controlled at the source to prevent the wear and tear of uncontrolled dust settling in valuable equipment. Request Bulletin 922.
96 *Pangborn Corp.

Dust Collectors.....Dustube dust collectors with efficient, economical ultra filtration collect fine atmospheric dust at low cost and with unusually high efficiency. Catalog 372C.
64 *Wheelabrator Corp.

*From advertisement, this issue.

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Gas Supply TRAILERS

TRANSPORTING — Argon — Carbon Dioxide — Helium—Nitrogen— Oxygen — Boron Trifluroide — Hydrogen — Ethylene. Trailer capacities from 187,000 cu. in. to 750,000 cu. in. water capacity. Trailer tubes ICC3A-2400 Specifications with 2400 PSIG Working Pressure.

Sizes and weights to meet all State requirements.

Can be mounted on bases for permanent storage.

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CONSULTING · RESEARCH · DESIGNING
O'FALLON 7, ILLINOIS

faster, lightweight

HYDRAULIC PIPE BENDER

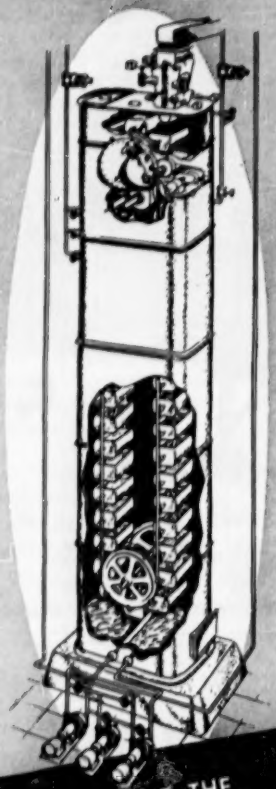
GREENLEE NO. 880

Bends pipe or conduit 90° with one ram stroke
Handles ½-in. to 2-in. pipe or conduit
Rugged aluminum alloy construction slashes weight
Every bend perfectly uniform
One man easily carries and operates it anywhere
Separate two-speed hand pump and ram give faster handling and setup
Operates with fast GREENLEE 798 Power Pumps
Thin-wall conduit, tubing, and bus bar attachments available
Write for illustrated Bulletin E-217

Also: Ask about the new GREENLEE No. 884 Hydraulic Pipe Bender . . . bends pipe and conduit up to 4" full 90° in one fast stroke.

GREENLEE
GREENLEE TOOL CO.
2432 Herbert Ave., Rockford, Illinois

FRENCH
BASKET TYPE EXTRACTOR



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- Developed and perfected by more than 50 years of application in the oil milling industry.
- Over 50 operating plants producing top quality product with low operating and maintenance costs.
- Standard sizes range from 25 tons to 1000 tons per day capacity.
- Let French help you solve extraction problems involving solids. Write today to French, Extraction Division, Piqua, Ohio.

FO4

THE FRENCH OIL MILL MACHINERY CO.

EXTRACTION DIVISION

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LITERATURE . . .

Evaporators.....New 8-p. brochure describes company's three types of water evaporators: Flash evaporator, vapor compression apparatus and centrifugal compression still.
462A Badger Mfg. Co.

Exhauster, Water Jet.....New large-capacity, high-economy exhauster now available. Suitable for closed system evacuation, handling non-condensables at low pressure, and mixing. Bul. 4P.
462B Schutte & Koerting Co.

Feeders.....Wet reagent feeders accurately meter minute quantities of liquid from 0 cc. to 2000 cc. per minute. Float valve in tank permits connection of feeder to bulk storage device. Bul. F6-B9.
366e *Denver Equipment Co.

Feeders, Rotary Airlock.....Bulletin P-55 contains specifications and data on line of standard duty and heavy duty rotary airlock feeders and Blow-thru feeders, with or without drives.
449 *Prater Pulverizing Co.

Filter Cloth.....Bulletin 10 gives complete technical data on all types of filter cloth. Includes Nylon, Dacron, Vincel, Orlon, Dynel, Teflon, Saran, cotton, glass and others.
462C National Filter Media Corp.

Filter Presses.....Sperry filter presses offer important improvements to speed your production, reduce operating costs, improve product quality, purity and uniformity. Filtration Catalog.
R466 *D. R. Sperry & Co.

Filters.....Auto-Klean filter offers micronic filtration down to 40 microns, positive, self-cleaning action, small size plus high flow rates, low pressure drop. Catalog SAK-057 has complete data.
328 *Cuno Eng. Corp.

Filters.....Bulletin 651 describes a diatomite filter for high quality process water recirculation. Bulletin 909 covers an automatic water filter for recirculation systems with less critical uses.
357 *R. P. Adams Co.

Filters.....Model ELS liquid filters can filter practically any liquid successfully. Any filtering material is available for every problem regardless of temperature or pressure needed. Bul. 300.
321 *Dollinger Corp.

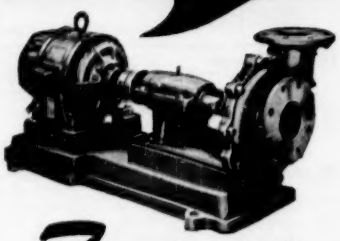
Filters.....New line of polish and trap Fulflo filters is announced in Bulletin PM-243. Designed primarily for breweries, filters can be used wherever there is need for micronic clarity.
462D Commercial Filters Corp.

Filters, Disc.....Patented segments in disc filters use both gravity and vacuum to give a drier filter cake. Drainage is complete, with no blow-back. Also drum and pan filters. Bulletin FC-B1.
366f *Denver Equipment Co.

Flotation.....Flotation is the selective separation of particles from each other in a liquid pulp by means of air bubbles. "Sub-A's" give maximum recovery at a low cost per ton. Bulletin F10-B81.
366g *Denver Equipment Co.

*From advertisement, this issue

Custom-built for EFFICIENT DEPENDABLE SERVICE



Frederick

SSV PUMPS

Enclosed Impeller and Open Impeller Types

You're sure of maximum service and output with minimum maintenance or production down time with Frederick SSV Centrifugal Pumps because each pump is custom-made to fit your particular operation—whatever the consistency or type of liquid you're moving.

SSV PUMP FEATURES

- **Pump sizes from 1" to 4" discharge openings.**
- **Pump capacities from 50 up to 700 U.S. GPM.**
- **Heads from 30 up to 220 feet.**
- **Pumps speeds can be varied to suit the driving media and operating conditions.**

CONSTRUCTION ADVANTAGES

Pump casings are vertically split for easy accessibility. Mounted on a swivel to permit placing discharge in any desirable position. Pump openings, both suction and discharge, flanged to permit easier connection and disconnecting to joints. One-piece impellers, securely attached to shaft by stout key and lock nut, or threaded, give long service. Pump bearings mounted in sturdy frame horizontally split for easier accessibility. Extra long stuffing box provides for oversize stuffing. Mechanical seal also available for minimum leakage. Pump coupling flexible for direct connection to drivers or can be arranged for belt drive. Pump speed, pump openings, etc. are selected to suit your particular requirements.

Write for Bulletin No. 107

FREDERICK PUMPS

FREDERICK IRON AND STEEL, INC.
FREDERICK Est 1890 MARYLAND

LUZERNE

PVC PIPE & FITTINGS

Will Help Solve Your Corrosion Problems!

Having trouble with corrosion or internal build-up of slime and scale in your piping? The smooth inside surface of LUZERNE rigid, unplasticized Polyvinyl Chloride Pipe and Fittings means less of this difficulty; and because it's non-metallic, electrolytic action is eliminated, too.

LUZERNE PVC Pipe and Fittings are light in weight, easy to install with either screwed fittings or welding socket fittings, and economical. Sizes ½" to 12". (Large sizes on request.)

SEND FOR BULLETIN PVC 1200

LUZERNE offers an improved and expanded line of HARD RUBBER VALVES for Chemical Applications . . . Flanged . . . or Threaded Screw Straight Way Valves . . . Screw Stem Angle Valves . . . Globe Valves . . . all with improved Du Pont Teflon packing.

See
LUZERNE EXHIBIT
in
BOOTH NO. 435

The LUZERNE RUBBER CO.
100 Muirhead Avenue, Trenton, N. J.

LITERATURE . . .

Generators.....Model "R" Amesteam generator is available in sizes from 10 to 150 HP for pressures up to 250 PSIG, for oil, gas or combination oil-gas firing equipment. Model "R" Bulletin.
373 *Ames Iron Works Inc.

Generator, Inert Atmosphere.....New inert gas system outlined in Bulletin I-457. Gives flow charts, cost analyses and typical installations in petrochemical and metal industries.
463A Gas Atmospheres.

Generators, Inert Gas.....Kemp inert gas generators have a carburetor which gives exacting control to the generation of inert gases. These are low-cost inerts, for many applications. Bulletin I-10.
32 *C. M. Kemp Mfg. Co.

Mills, Ball.....Steel-head ball mills have five types of discharge trunnions, all-steel construction, low initial cost due to quantity production, quick delivery. Request Bulletin B2-B13.
366b *Denver Equipment Co.

Mixers.....Company presents easy-to-use, comprehensive mechanical design information permitting catalog selection of complete paddle and turbine type fluid mixers. Catalog A-27.
20 *Phila. Gear Works

Mixers.....Company offers an informative treatise on equipment and systems for processing dry and semi-dry materials. Mixers, bulk conveying equipment, grinders, etc. Bulletin 95.
117 *Sprout-Waldron Co.

Mixers.....Only Agi-Mixers give homogenizing and paddle mixing at the same time. They have rotating paddles with Teflon scraper blades. Send for free 24-page Fact Book on whole line.
R463 *Gifford-Wood Co.

Mixers, Portable.....Versatile portable mixers can be quickly shifted from task to task to allow one mixer to serve many heads. Available from 1/20 to 5 H.P. Send for Eastern Bulletin 520-A.
B460 *Eastern Industries Inc.

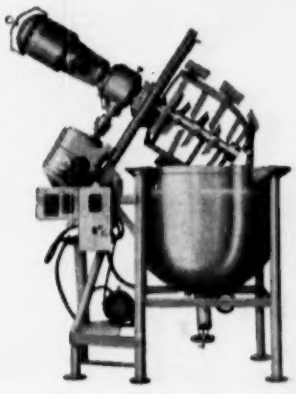
Mixing Equipment.....Bulletins are available on top and side entering agitators, portable mixers, mixing and extruding machinery, dry blenders, ribbon mixers, grinding and mulling pans, etc.
455 *International Eng. Inc.

Process Equipment.....Eleven job-proved rubber and plastic materials are now available in Ace piping, valves, pumps, and tanks. Tough Ace Ite rubber-plastic blend, Saran, Tempron, etc. Bul. CE-50.
323a *Amer. Hard Rubber Co.

Process Equipment.....Dryers, evaporators, flakers, autoclaves, kettles—all the units in Buflovak line incorporate advanced design features developed by extensive product research. Catalog 380.
40-I *Blaw-Knox Co.

*From advertisement, this issue

This typical G-W Eppenbach Agi-Mixer is fully jacketed. Hydraulic lift raises mixing assembly. Contact parts are stainless steel.



only Agi-Mixers give

HOMOGENIZING PADDLE MIXING

at the same time!

...That's why hundreds of users have found G-W Eppenbach Agi-Mixers just about the most useful processing equipment they possess.

Rotating paddles with teflon scraper blades work unrefined material down from the edges and top of the kettle to the high-speed, high shear Homo-Mixer homogenizing head. Here the material is drawn through small clearances between a precision turbine and stator, and ejected upward against an adjustable deflector plate. At this point the paddles again direct the material down, and this cycle is repeated until the entire mass is properly homogenized and blended.

G-W Eppenbach Agi-Mixers are built for rugged, exacting, time-saving service, and have scores of uses in processing pastes, creams, batters, slurries, gums, adhesives, pigments, resinous and latex compounds, and other viscous products. 3810

Use coupon for free 24-page Fact Book describing the whole unusual Eppenbach line.

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Please send me your free Eppenbach Fact Book.

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Announcing
the New
Jerguson
MAGNETIC
GAGE
For Liquid Levels

An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

For pressures up to 2500 lbs. @ 600° F.

Patent Applied For

Can also be used for interface indication.

Write now for engineering sheet on Jerguson Magnetic Gages.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
In Canada: Peacock Bros. Ltd.

LITERATURE . . .

Process Equipment.....New 4-p. bulletin describes complete line of carbon and graphite products for chemical processing. Gives data on heat exchangers, pipe, valves, fittings and others.
464A National Carbon Co.

Process Equipment, Corrosion-Resistant.....Bulletin 947 is illustrated capsule of complete line of Pfaudler equipment and services ready to help you in the fight against corrosion.
464B Pfaudler Co.

Process Equipment, Graphite.....32-page report presents costs and equipment specifications on all the standard impervious graphite processing equipment made by company. Bulletin 249.
361 *Falls Industries Inc.

Pulp Refiner.....Designed for all pulping applications where rubbing and brushing without cutting are required, Single-Rotating-Disk Pulp Refiner is fully described in Bulletin 185.
464C Sprout, Waldron & Co.

Reactors, Glass-Lined.....Spherical, glass-lined reactor is designed to operate at 330 psi internal pressure and 250 psi in the jacket. Shorter agitator shaft, one main seam. Bul. MG-100.
54-J *Glascote Products Inc.

Reactors, High Pressure.....Company presents a convenient source of information on laboratory and pilot plant high pressure reactors up to 100,000 p. s. i. Details, specifications. Bulletin 357.
376 *Autoclave Engineers.

Samplers.....Heavy-duty units, rigid track and ball bearing wheels assure positive travel and timing of automatic sample cutter available in stainless steel for acid and corrosive service. S1-B4.
366e *Denver Equipment Co.

Separators.....Fines that pass through grinding mills unhindered, serving only to increase the work load, can be quickly classified by an air separator working in closed circuit. Bulletin 687.
408 *Sturtevant Mill Co.

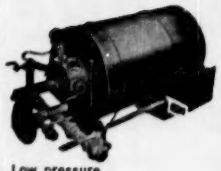
Stack Sprays.....Reduce dust emission during dust blowing; publication 500-330 shows how water sprays when properly installed slash dust emission. Lists manufacturers of spray equipment.
464D Bituminous Coal Research.

Strainers.....Bulletin S-205 gives full story on Yarway strainers. Designed for maximum fine straining with minimum flow restriction. Screens of Monel wire resist corrosion.
464E Yarnall-Waring Co.

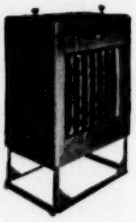
Strainers, Line.....OPW line strainers protect your pump, meter and loading valve against scale, grit, dirt, rust and other foreign materials. Tight fit of cage and screen. Bulletin F-36.
18 *Jordan Corp.

Tables, Concentration.....Mechanically operated, longitudinally reciprocating table separates materials into bands and handles the coarsest sands with excellent results. Bulletin T1-B3.
366h *Denver Equipment Co.

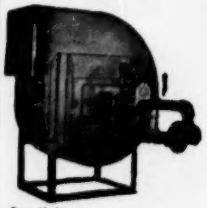
*From advertisement, this issue.



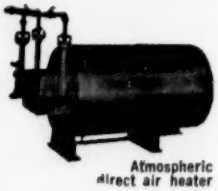
Low pressure direct air heater



Indirect air heater



Scroll type direct air heater



Atmospheric direct air heater

HOW TO SAVE WITH CONVECTION HEATING

Here's a sure way to save fuel and space wherever a chemical process requires convection type heating. Specify "Surface" air heaters and get these returns:

Save fuel with automatically correct gas-air ratios, rapid and uniform heating, maximum volume air flow. Use natural, manufactured, or LP gas.

Save installation costs with compact design and complete air heater assembly.

Single burner unit requires only one safeguard system for each air heater installation.

Build these savings into your convection heating equipment now. Call your "Surface" representative, or write for Literature Group H54-15.

Surface
HEATING EQUIPMENT

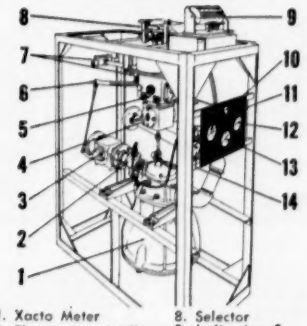
SURFACE COMBUSTION
CORPORATION, TOLEDO 1, OHIO

Blends many liquids automatically with unexcelled accuracy

Bowser precision proportioners automatically and accurately blend two or more liquids in closed, continuous production.

A simple setting of the percentage selectors provides any variation of blend from ½% to 100%. XACTO, "the world's most widely used meter," assures perfect proportioning of all liquids being mixed, compounded or blended.

SIMPLICITY OF DESIGN SAVES SPACE . . . REDUCES MAINTENANCE



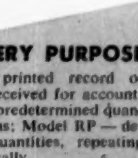
1. Xacto Meter
2. Thermometer Well
3. Inlet Control Valve
4. Differential
5. Control Nut
6. Valve Control Arm
7. Pump Control Circuit & Switch
8. Selector
9. Indicating & Totalizing Dial
10. Flow Indicator
11. Inlet Pressure Gauge
12. Discharge Pressure Gauge
13. Dial Thermometer
14. Discharge Check Valve

DIALS FOR EVERY PURPOSE

Model K — furnishes printed record of quantity dispensed or received for accounting; Model P—delivers predetermined quantities up to 10,000 gallons; Model RP — delivers predetermined quantities, repeating each quantity automatically.

FREE OFFER . . .

Write for full color, 12-page Facts Folder titled, "XACTO PRECISION BLENDING SYSTEM."



BOWSER INC.
1375 E. CREIGHTON AVE.
FORT WAYNE, INDIANA

LITERATURE . . .

Vacuum Assemblies.....Company supplies a complete package unit on wheels that can be moved from one job to another. These Portovac assemblies are economical and efficient. Request Bulletin 70-A.
343 *Graham Mfg. Co.

Wire Cloth.....Nine weaves ranging from the finest to the coarsest, in any metal or alloy. Accurately woven, with careful inspection for accurate mesh count and uniform mesh size. Catalog.
324 *Cambridge Wire Cloth Co.

Pumps, Blowers, Compressors

Compressors.....If you need oil-free air, take advantage of Joy's more than 25 years of experience with non-lubricated compressors and send for your free copy of helpful Bulletin 130-11 now.
9 *Joy Mfg. Co.

Compressors.....Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylating or any similar service, send for Bulletin 0504.
184 *De Laval Steam Turbine Co.

Compressors.....Axi-Compressors for pressure and vacuum, for air, gases, vapors have compact, rugged construction, smooth, shockless flow, oil-free delivery. Performance curves in Bul. 11,001.
211 *Ingersoll-Rand.

Fans.....Type "BL" fan assures you of dependable, economical, long-lasting air-moving service for your particular air conditioning, ventilating or other industrial application. Bulletin F-102.
76 *Buffalo Forge Co.

Fans, Centrifugal.....Bulletin PVC-101 describes use of rigid polyvinyl chloride in five centrifugal fan models for installations requiring high chemical resistance. Request details.
465A Chicago Blower Corp.

Fans & Ejector Stacks.....If your problem is conveying or evacuating erosive, corrosive, explosive or high temperature gas, an out-of-circuit PD fan and ejector stack is the answer. Bul. A572.
315 *Thermix Corp.

Pumps.....Twin-Lobe rotary positive displacement pump has simple construction with only three moving parts, high mechanical efficiency, lower horsepower, wide range of uses. G.T.A./TLP-57 Bulletin.
401 *Manton-Gaulin Mfg. Co.

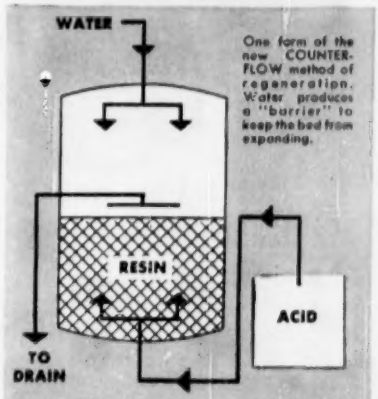
Pumps.....Company maintains a factory stock of the most commonly used sizes of centrifugal pumps for immediate delivery. Vertical split-case design, non-overloading motors. Catalog CSP-257A.
123 *Bell & Gossett Co.

Pumps.....Company offers Catalog 752, "Stokes Microvac Pump for High Vacuum" and Booklet 755, "How to Care for Your Vacuum Pump". Compact, minimum maintenance, wide pressure ranges, no dirt.
126 *F. J. Stokes Corp.

*From advertisement, this issue.

ILLCO-WAY
ionXchange

COUNTERFLOW*
REGENERATION OF ION-EXCHANGERS


WATER
One form of the new COUNTERFLOW method of regeneration. Water produces a "barrier" to keep the bed from expanding.
RESIN
ACID
TO DRAIN

* "COUNTERFLOW" is the trade mark of Illinois Water Treatment Company equipment utilizing a distinctly new principle of regeneration. Pat. pending.

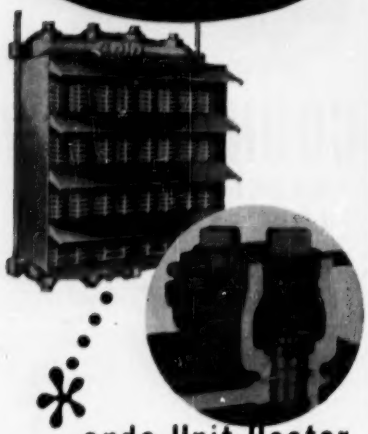
- Ion leakage is reduced to about 1/3 of the amount common to conventional regeneration techniques.
- There is an increase of approximately 10% in cation resin capacity, with no increase in amount of acid regenerant.
- Removal of organics from the resin is improved.
- The possibility of calcium sulfate precipitation is decreased, permitting single-stage regeneration.
- Rinse water requirements are reduced.
- In systems using a two-bed deionizer ahead of a mixed-bed unit, ions can be removed more completely in the more efficiently regenerated two-bed unit, thereby reducing the load on the mixed-bed unit.

Present users of "COUNTERFLOW" are enjoying IMPROVED purity of effluent at LOWER cost of regenerant materials. One power plant, for example, is saving $16,000 a year on acid alone since converting existing de-ionizers to COUNTERFLOW design.

ILLCO-WAY
ILLINOIS WATER TREATMENT CO.
840 Cedar St.
Rockford, Ill.

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

GRID* Cast Iron Steam Heat Transfer Surface



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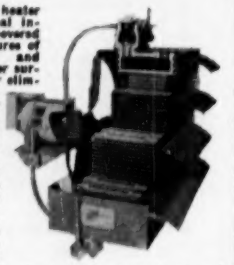

Note double steam chambers in each fin section and wide fin spacing.

Above illustration is all cast iron one-piece, single chamber fin section used in Models 1000 and 1200.

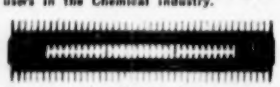

Illustration above is all cast iron one-piece double chamber fin section used in Models 1500 through 3000 . . . wide fin spacing prevents clogging by lint or dust . . . straight through air passage reduces resistance. Single inlet at top serves both steam chambers permitting quick, even steam distribution.

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LITERATURE . . .

Pumps.....Taber vertical and horizontal pumps for alkaline solutions, acids, solvents (hazardous and toxic) are made of all castable and machinable metals. Buls. V-837, C-355, S-146.
171 *Taber Pump Co.

Pumps.....Heliquad pumps give greater suction lift than other pumps because the entrance chamber is large and open, and the rotor design develops larger openings. Request helpful Bulletin L-54.
191 *Kinney Mfg. Div.

Pumps.....Type DS rubber-lined pump for pumping corrosives or solutions containing abrasive solids is non-corrosive, non-clogging. High temperature pump has water-cooled bearings .Bulletin 982.
101 *Buffalo Pumps Div.

Pumps.....Each Layne pump is specifically engineered for its particular job; there is no stock Layne pump. Company knows strata, water requirements and usage. Bulletin 100 is offered.
79 *Layne & Bowler Inc.

Pumps.....New Roper pump with steam chest is a low cost method of heat transfer to pump and packing and for handling thick, viscous liquids. Can be used with steam, hot water or oil. Bulletin 29.
452 *Roper Hydraulics Inc.

Pumps.....Vertical pumps with no submerged bearings for pumping abrasive, corrosive, or slurries. Extra heavy shaft, double-ported casing, tough, abrasion-corrosion resistant alloys. Bul. 203-7.
367 *Lawrence Pumps Inc.

Pumps.....Type S pumps have oversized cross heads, liquid ends, long-wearing connecting rod bearings, easily accessible packing glands, stainless steel piston. Send for Bulletin S-1254.
335 *Phila. Pump Div.

Pumps.....A number of Goulds centrifugal pumps now come in a wide range of special metals, including bronze, Ni-resist, iron, nickel aluminum bronze, steel and steel alloys. Bulletin 5252-J.
448 *Goulds Pumps Inc.

Pumps.....SSV enclosed impeller and open impeller type pumps have accessible, vertically split casings, speeds which can be varied to suit the driving media and operating conditions. Bul. 107.
R462 Frederick Iron & Steel.

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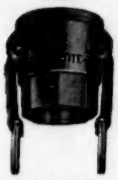

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Pumps.....New line of pumps with capacities from 27 to 223 gpm. are equipped with steam chest; can be driven by truck mounting or integral gear reduction with electric motor.
467A Roper Pump Div.

Pumps, Acid.....Jabsco neoprene-impeller pump of hard rubber outlasts, out-pumps anything in its pressure, size and price class. From 15 gpm. at 22 ft. head to 5 gpm at 72 ft. head. Bul. 97-A.
322b *Amer. Hard Rubber Co.

Pumps, Acid.....Ace "Wam", the finest non-metallic acid pump, has hard rubber casing and impeller, Hastelloy C shaft. Handles nearly all corrosives. Mechanically simple. Bulletin CE-55.
323L *Amer. Hard Rubber Co.

Pumps, Filter.....All-plastic filter pumps are suited for filtering corrosive solutions; removes particles down to 1 micron. Wide choice of materials of construction. Request details.
467B Sethco Mfg. Co.

Pumps, High Pressure.....Bulletin G-537 describes and illustrates Stellar-Flo sanitary pumps for high-pressure liquid transfer, metering and spray drying systems. Request details.
467C Cherry-Burrell Corp.

Pumps, Polyethylene.....A polyethylene pump is now being made for use with inflatable boats and mattresses. Iar is trapped inside the bag by folding the top together. TD 1298.
378Bj *U. S. Industrial Chem. Co.

Pump, Precision.....New duplex model pump for precision pumping, feeding and proportioning of liquids at micro flow rates is described in Bulletin 500. Maximum flow rate is 2,300 ml./hr.
467D Lapp Insulator Co.

Pumps, Vertical Turbine.....The cost of a vertical turbine pump is small in comparison with the savings on costs of water it accumulates year after year. Request Bulletin 4700.
441 *Deming Co.

Services, Processes, Misc.

Color Code Chart.....Handy, durable chart containing color codes and calibration symbols for thermocouples and extension wires; also gives pyrometer wire resistance figures.
467E Thermo Electric Co.

Consulting Engineers.....Booklet gives full run-down of the company's facilities. Discusses scope of activities, list clients, includes a complete record of the background of all personnel.
467F Kaphael Katzen.

Copying Equipment.....8-p. brochure describes Xerox copying equipment. Explains copying process and lists general duplicating requirements with suggestions for cutting costs and speeding work.
467G Haloid Co.

Cost Reduction.....Information is given about a cost area that Equip-to, over the past 50 years, has found

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LITERATURE . . .

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468A Equipto Div.

Distillation.....8 p. folder describes company's analytical distillation and vapor-phase chromatographic apparatus. Includes photographs, specifications lists and application data.
468B Podbielniak, Inc.

Engineering & Construction.....This corporation is experienced and equipped to help you with design, construction, consulting engineering, reports, appraisals and examinations. Free booklet.
69 *Stone & Webster Eng. Corp.

Engineering & Construction.....From engineering and design, through purchasing and expediting, field construction, even through training personnel and putting plant into operation. Bul. E-7-32.
124 *Southwestern Eng. Co.

Engineering Development Center..... 16-page brochure describes new 150,000 square-foot center to help you bridge the gap between laboratory research and successful production, a major service.
149 *Lummus Co.

Engineering Services.....6 p. bulletin describes company's engineering and design services designed to alleviate peak loads on existing engineering departments and supply specialized abilities.
468C Allstates Design & Dev.

Epoxidation.....Two new procedures for in-situ epoxidation reactions with resin catalysts are described in 3 p. bulletin 89. One involves continuous circulation of reactants, the other is very simple.
468D Becco Chem. Div.

Felt Cleaning.....Clinton Sulfadine is a versatile, general-purpose felt cleaner designed especially for papermakers. Cleans felts without shutdowns and without alkaline rinse.
468E Clinton Chemical Co.

Fire Research.....A pamphlet on fire research reports on the facilities, personnel and management of the principal agencies engaged in this work. Also describes tests of various materials. TD 1297.
378Bi *U. S. Industrial Chem. Co.

Glass Apparatus.....“What's New for the Laboratory,” 16 p., illustrates and describes such new items as Geyomatic burettes with automatic zero, paraffin dispenser, two new Powerstats.
468F Scientific Glass.

Hydrants.....There are sizes and types of Darling fire hydrants for every conceivable installation requirement; they have ball bearing operation and “O” ring seals. Bulletin 5403.
340 *Darling Valve & Mfg. Co.

Laboratory Apparatus.....Catalog 7 contains over 900 p. on laboratory apparatus including charts comparing similar apparatus, prices, reference tables summarizing related items, specifications.
468G Will Corp.

Laboratory Equipment.....Batch and continuous test models of crushers screens, ball mills, pulverizers, rod mills, classifiers, agitators, mixers,

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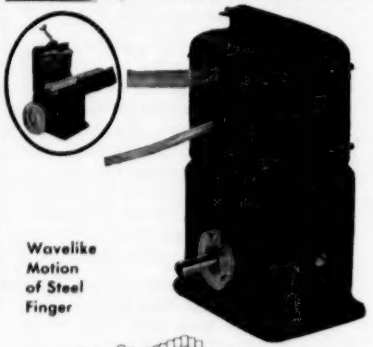

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pulp distributors, etc. Bul. LG3-B10.
366i *Denver Equipment Co.

Metal Etching.....Two processes—chemical etching and electrolytic etching—are described in Bulletin 90. Illustrates great variety of industrial parts formed by processes.
469A Superior Tube Co.

Odor Treating.....Bulletin 70 describes a process for destroying industrial organic odors. Low temperature catalytic oxidation converts fumes and vapors to odor-free gases.
469B W. C. Holmes & Co.

Pilot Plants, Polymer.....Bulletin 705 details company's service for complete engineering and building of polymer pilot plants and semi-commercial facilities. Much technical detail.
469C Crawford & Russell.

Rust Prevention.....4-p. brochure outlines company's rust prevention system. Tells where, when and how to use primer and finish coat; gives results of actual field tests.
469D L. Sonneborn Sons Inc.

Spectrograph, X-Ray.....8-p. booklet gives complete information on improved Norelco Autrometer, automatic indexing X-ray spectrograph. Analyze 1 to 24 elements in a single sample.
469E Phillips Electronics.

Soap Processing.....Brochure describes equipment for continuous manufacture of soap bars. Chalks up considerable savings over convential batch methods of processing.
469F Meccaniche Moderne.

Thermal Conductivity Cells.....Bulletin TC-12-57 contains specifications on signal strenth, response time, flow, temperature and operating currents for users of gas analysis apparatus.
469G Gow-Mac Instrument Co.

Ultracentrifugation.....8 p. booklet SBE-25 provides a summary of the various rotors and their cells and accessories which are available for the widely varied purposes of analytical ultracentrifugation.
469H Beckman Instruments.

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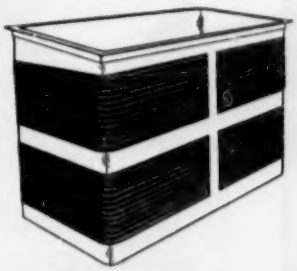

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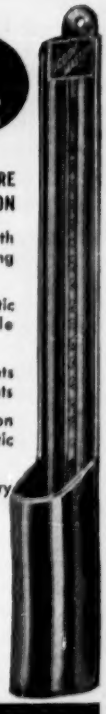

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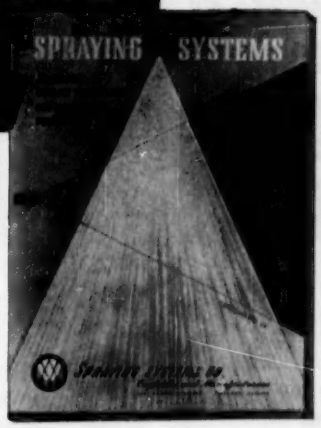

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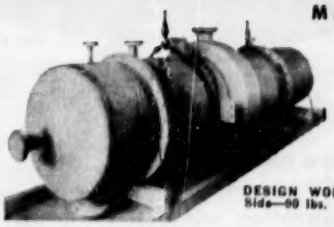

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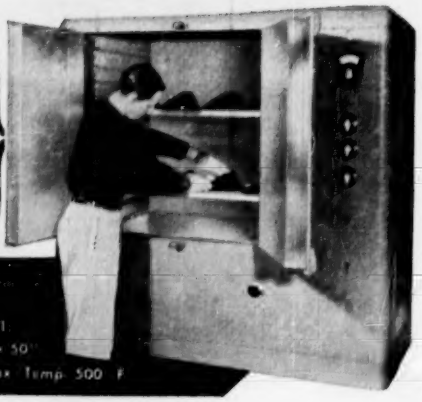

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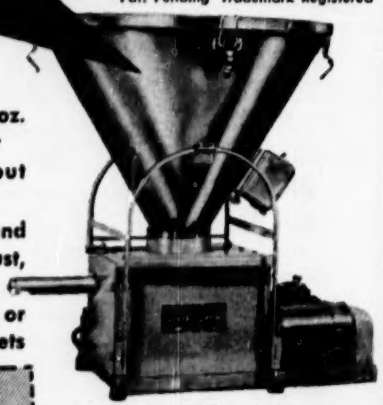

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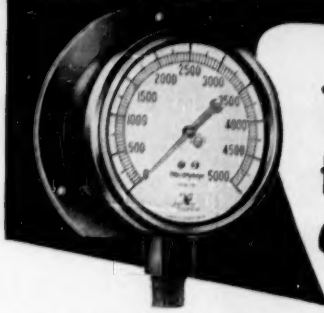

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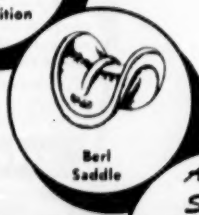

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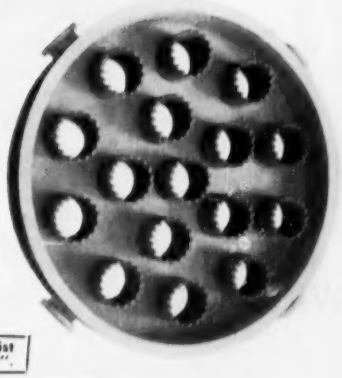

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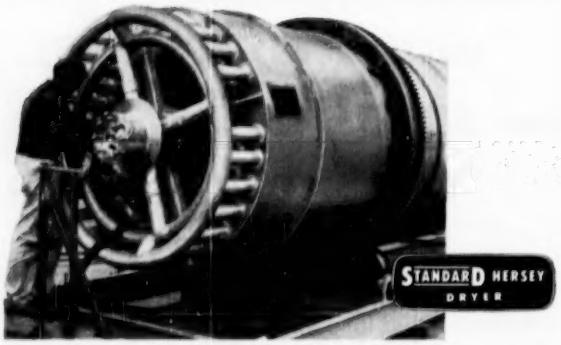

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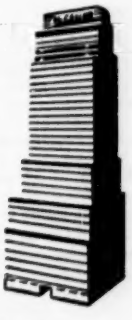

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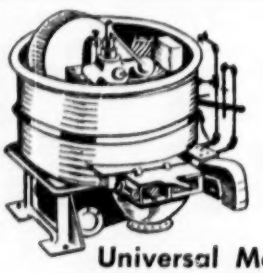
Mitts & Merril 30" x 36" Model 15CF Hogs

HEAT & POWER Co., Inc.
PROCESS EQUIPMENT DIVISION
60 East 42nd St. New York 17, N. Y. MUrray Hill 7-5260
310 THOMPSON BLDG. TULSA 3, OKLAHOMA Diamond 3-4890



#0 SIMPSON INTENSIVE MIXERS NEVER USED

Style: M . . . Diameter: 3' Capacity: 1¾ cu. ft.
ACQUISITION COST: $2935. each
OUR PRICE: $1495.
each complete with 5 Hp motor & drive.

Universal Machinery & Equipment Company
1630 NORTH NINTH ST., READING, PA. — PHONE FRanklin 3-5103 COLLECT

LOEB OFFERINGS

Autoclave: 50 gal. Struthers-Wells, st. st.
Boilers: Gas fired 60, 15, 2, 1 hp.
Centrifugals: Fletcher 12" copper.
Fletcher 20" lithcoated.
Tolhurst 28" copper.
Tolhurst 24", rubber covered.
Centrifuge: Inter. size 3 mod. FS. 2 hp.
Clarifiers: De Laval 34-51, SVK5R, 04-21.
De Laval #800 multiple.
Condensers: stainless steel and copper.
Crystallizers: 500 gal. stainless steel, jack.
Dryers: Devine 2 x 4' vac. drums, st. steel.
Bowen laboratory Spray type.
Ruggles Coles XA 4 x 20' rotary.
Double drum atmospheric to 120".
Louisville Davenport Steam Tube.
Nordyke rotary steam 120 bu/hr.
Evaporator: Buflovak double effect st. st.
Fillers: for liquid, paste, powder.
Filters: Oliver 2½ x 1', Sparkler, Alsop, Lomax, Industrial.
Eimco 4x3 steel drum, unused.
Oliver 6x4 s. s. drum with flapper.
Sweetland 24" stainless steel.
Filter Presses: Sperry, Shriver 6" to 36".
Kettles: Stainless steel 20 to 500 gal. with and without agitators.
Dopp 150 gal. dbl. st. agitator.
Mills: Pebble, Abbe #5, 36 gal.
Ball: 4 x 5' chrome manganese.
26 x 42" chrome manq., jack.
Mikro: Bantam, #1SH, #2TH, 24".
Hammer: Jeffrey 30 x 24" type A.
Hammer: Williams size BX type AX.
3-roll: high and slow speeds.
Colloid: Charlotte iron, 25 hp.
Colloid: Charlotte model 20, st. st., 20 hp.
Mixers: Dbl. and sgl. arm sigma blade.
Jacketed horiz. 550 gal. st. steel.
Dry Powder: 1½ to 77 cu. ft.
Day Powder, copper body, 140 cu. ft.
Liquid tank to 500 gal.
Muller: Simpson st. st. bowl 39x20".
Pony: Day 40 gal. Ross 20 gal.
Gemco st. st. Tumbler, 7½ hp.
Percolators: Pfaudler 54 x 42" st. st. jack.
Press: Louisville dewatering 10x22" rolls.
Pumps: Centrifugal, rotary, gear, vacuum. In various sizes and metals.
Reactor: VanAlst st. steel 18 x 60".
Pfaudler 300 gal. st. st. agit.
Screens: Selectro 4 x 10'.
Tyler model 300, 5 hpl.
Separators: De Laval AC-VO Nozzle-Matic.
Sterilizers: American 42 x 52" x 11½' lg.
Stills: st. steel 24 x 45", 24 x 32", 20 x 24".
Tablet Machines: Single punch and rotary.
Tanks: Stain. steel, various sizes.
St. steel 2000 gal. jacketed.
Vacuum Pan: 42" Harris st. steel.
Pfaudler 300 gal. stain. steel.

Send us your inquiries and list of idle equipment

LOEB EQUIPMENT SUPPLY CO.

818 West Superior St. Chicago 22, Ill.
Telephone: Seeley 8-1431 Our 33rd Year

2—Vac Shelf 6 & 20 Shelf Dryers, 40 x 40".
2—Fletcher 30" x 48" S.S. Centrifugals.
1—72" Stainless Bubble Cap Column.
6—Stainless Steel Tanks 300 - 750 - & 1200 gals.
1—Stokes Microvac Pump 115 cfm.
1—Porter 40 gal. S.S. Pony Mixer.
8—Porcelain lined Pebble Mills 15 & 30 gals.
2—Lightnin' 7½ H.P. top entering Agitators, 100 r.p.m.

Complete listings - Bulletin A-39
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THE MACHINERY & EQUIPMENT CORP.
293 Frelinghuysen Ave., Newark 12, N. J.
TAlbot 4-2050

CONDENSERS FOR SALE

3—BRAND NEW "WHEELER" 2-pass, 725 Sq. Ft. Surface Condensers —equipped with Copper Nickel Tubes and Tube Sheets—Bronze Water Boxes.

Print and Operating Data available.

Price:—$3,250.00 each

J. A. DOUGHERTY
P. O. Box 90 Bala-Cynwyd, Pa.

LIQUIDATION
RUBBER RECLAIMING PLANT
TRENTON, N. J.

1—Rot. Hot Air Dryer, 9' x 30', St. St. lined.

8—1800 gal. Jktd. & Agit. Steel Digesters, 6' dia. x 8'8" high, dished heads 1" thick, shell 5/16" thick, 5/8" jkt.

1—Davenport #2A Dewatering Press.

1—Detroit Underfeed Stoker, 500#/hr.

1—Robins 3' x 10' single deck screen.

1—Elmore 3-stage washer, 6' W x 10' L x 10' D.

Conveyor, Steel Tanks, Bucket Elevator, Motors, Pumps, etc.

AUTOCLAVES—REACTORS

6—465 gal. St. St. 3' dia. 8'6" deep, 150# WP, 165# jkt. pr.

3—Pfaulder Glass Lined, jktd. & agit. 30 gal., 50 gal., 100 gal., 500 gal.

3—St. St. T347 13 gal. 1400# test, 50# jkt.

1—1500 gal., steel, ASME 600# W.P. 150# jkt.

CENTRIFUGALS

3—Bird 24" x 24" Horiz. Centrifugal screen filters, monel.

1—Bird 24" x 38 monel, Solid Bowl.

2—Bird 32 x 50 Solid Bowl Centrifugals, Type 316 Stainless Steel, fume-tight, 60 HP motor. Built 1953.

1—Bird 36" x 50" Solid Bowl, Steel.

1—Bird 40" x 60" Solid Bowl, T304 S. S.

1—AT&M Susp. 48" dia. Perf. Basket, St. St. Fume tight.

2—Fletcher Susp. 40" dia. Basket, 1 perf. plain steel, 1 rubber covered perf.

1—Fletcher 12" dia. St. St. Solid Basket.

1—Sharples C-20 Super-D-Hydrator, T316 St. St.

1—Sharples #16-VS, clarifier bowl.

2—Sharples #16V, St. St. Sep. Bowl.

2—DeLaval #BUH-3930 Hermetic Clarifiers, Stainless Steel.

WE ARE
STAINLESS STEEL HEADQUARTERS
TANKS

3—2950 gal. Heil St. St. Trailers.

1—3590 gal. Fruehauf St. St. Trailer.

2—NEW 5700 gal. Horiz. St. St. Tank.

2—NEW 10,500 gal. Horiz. St. St. Tank.

1—24,500 gal. Alum. Tank.

USED EQUIPMENT IN STOCK. Tanks, Kettles, Receivers, Exchangers and Condensers, Stills, Agitators, etc.

NEW TANKS IN STOCK—From 30 gal. to 10,500 gal. sizes. Also large stock of prefabricated tank sections and heads to assure quick delivery of tanks.

COME SEE 4 ACRES OF EQUIPMENT IN STOCK

EVAPORATORS—STILLS—COLUMNS

1—Buflovak size 6.5 model 629D Double Effect, all stainless steel, 588 sq. ft.

2—Nickel Clad single effect evaporators, 250 & 400 sq. ft.

1—Bartlett Snow, St. St. Jacketed Evaporating Kettle 6' dia. x 3' deep with heavy duty agitator and 25 HP 4-speed drive.

2—Stainless Steel Dairy type 6' dia. Vacuum Pans with Coils.

1—Struthers-Wells Single Eff. St. St. 625 sq. ft. vertical tubes.

1—Stainless Steel 145 sq. ft. coil, 500 gal.

1—150 gal. Jacketed Vacuum Pan St. St.

1—Stokes type 316 St. St. Double Effect water still, 250 GPH.

8—Copper Bubble Cap Distillation Columns, 24" dia. to 48" dia.

DRYERS

1—St. St. Spray Dryer, 19' x 20', complete with building avail. for lease, Camden, N. J.

3—Stokes Rotary Vacuum Dryers 3' x 15', 3'6" x 15', 5' x 15'.

4—Rotary Hot Air Dryers, 3' x 15', 3' x 24', 4' x 30', 4'6" x 32', 4'6" x 40'.

4—Rotary Steam Tube Dryers: Louisville 4' x 30', 6' x 30', 6' x 40', 6' x 45'.

2—A. L. Andersen Vacuum Shelf Dryers, 108 sq. ft., T316 St. St.

1—Devine #23 Vac. Shelf, 356 sq. ft.

2—Devine #17 UNUSED Vac. Shelf Dryers, 80 sq. ft.

5—Double Drum Dryers: 42" x 120", 42" x 100", 24" x 60", 22" x 38".

1—American Double Drum Vacuum Dryer, 36" x 84".

PRIME PROCESS EQUIPMENT

2—Patterson 8' x 10' Pebble Mills, brick lined.

1—42" x 120" American Double Drum Dryer.

1—Baker-Perkins size #15—100 gal. Dispersion blade mixer, St. St.

3—Beaird "Challenger" Rotary Hot Air Dryers, 4' x 30'.

1—3000 gal. T316 St. St. Tank, 5' x 20', ASME 100#, UNUSED.

3—1070 sq. ft. St. St. exchangers, ASME 150#.

1—Buflovak 5' x 12' VACUUM single Drum Dryers, UNUSED.

4—Nash "Hytor" Vacuum Pumps, size #28 (like H-10), 1500 CFM.

3—Davenport #1A Dewatering Presses.

1—Oliver Rot. Vac. Filter, 5'3" D x 8' F, Precoat, UNUSED.

2—Abbe stainless steel 50 gal. Sigma Blade Mixers.

MILLS

1—Allis-Chalmers Compeb Mill, 7' x 24', 450 HP motor.

1—Patterson ball-tube Mill, 5' x 22', UNUSED.

2—Hardinge Conical Mills, 10' x 96".

1—Al. Ch. Cont. ball mill, 6' x 16'.

5—Porter 6' x 5' Pebble Mills.

2—Patterson 8' x 10' Pebble Mills.

2—Cont. Pebble Mills, 6' x 8', 4'6" x 12'.

1—Batch pebble mill, 5' x 6'.

1—Raymond #50 Imp. Mill., 50 HP TEFC.

1—Jeffrey 54" x 30" Hammer Mill, 100 HP.

MIXERS—BLENDERS

7—Stainless Steel Sigma Blade double arm jacketed mixers, 5 gal., 10 gal., 50 gal.

7—Sigma Blade jktd. Mixers, 2¼, 35, 50, 60, 75, 100, 150 gal.

1—Robinson 110 gal. St. Clad jktd. Single Arm mass Mixer.

3—Sprout Waldron size 12 Ribbon Mixers, 336 cu. ft. work. cap.

1—Gemco St. St. 30 cu. ft. 54" dia., jktd. Conical Blender.

1—Conical Blender, Steel, 6' dia.

Cable PERI

PERRY EQUIPMENT CORP.

1413-21 N. 6TH ST. Phone POplar 3-3505 PHILADELPHIA 22, PA.

For Sale!

RUBBER LINED TANKS

42' 1. x 9'6" dia.
21'6" 1. x 10'6" dia.

MOTOR DRIVEN PUMPS

Stainless Steel, Duriron, Rubber Lined, Monel, Iron. Centrifugal, Gear, Steam Jacket and Impeller Types.

SPENCER TURBINE BLOWERS

Various Sizes

INFILCO WATER PURIFICATION UNIT & PUMPING STATION

NEW DURIRON PIPE & FITTINGS

MACHINERY & STEEL DIV.

United Iron & Metal Co.
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Baltimore 23, Maryland
Phone: Gilmor 5-5600

FOR IMMEDIATE DELIVERY
in good usable condition

MANTON-GAULIN HOMOGENIZER, 60 gals. per hr., 2 stage, bronze cylinders and valve chamber, Stellite valves and valve seats; 3 H.P., 550 v., 60 cyc., 3 ph., 1200 R.P.M. motor. Price $650. Without motor, $625.

WESTCO TURBINE (HIGH HEAD) PUMP, 2" both suction and discharge, Type SR-6K7, all iron, with spare parts, including extra impeller, driven by 3 H.P., 550 v., 60 cyc., 3 ph., 1800 R.P.M. motor, both mounted on base. Price $125. Without motor, $100.

ALBERGER LABORATORY AUTOCLAVE, cast iron, with stand and gas burner, approx. 1 gal. capacity; agitator and drive, 800 lb. gauge, safety valve. Price $156.

AUTOCLAVE, LABORATORY, special, steel, 7¼" diam. x 16" high, chamber 2⅛" diam. x 9⅛" high, with inner receptacle of nickel with gold plated interior, capacity approx. 660 cc. Has withstood 3000-3500 lbs. internal pressure. Price $150.

RAFTON LABORATORIES, INC.
Andover, Mass.

1—Hardinge Rod Mill 4' x 8' 50 H.P. H. Torque
7—Lightning Mixers—3 H.P. 431 RPM

3—Morris Cent. Pumps (Slurry)—
Size 2-R 150 GPM 60 ft head
Size 2 350 GPM 10 ft head
Size 2 120 GPM 120 ft head

1—Nash Double Suction Filtrate Pump Size D 34E 240 GPM 40 ft head
2—L. R. Chemical Pumps—Size 1½ MC 50 GPM 70 ft
1—L. R. Motor Blower—Type M-M310 (Volume C.F.M.—650)
1—50 H.P. Nash Hytor Vac. Pump Size H. 8
1—1½ ORV 3 I. R. Motor Pump 100 GPM 50 ft head
1—2 ORV 5 I. R. Motor Pump 225 GPM 50 ft head
1—Ross Dray Dryer
1—7½ H.P. Blower Rotary
1—1½ H.P. Small Blower Rotary
2—8' x 12' Oliver Vacuum Drum Filters
4—6 x 6' Eimco Vacuum Disc Filters
1—15 H.P. Nash Hytor Vacuum Pump Size H-6
3—20 H.P. Nash Hytor Vacuum Pump Size H-6
1—4' x 6' Eimco Drum Filter
1—Small Pug Mill 5 H.P.

3—Lengths 12" Screw Conveyor with motor drive
1—Length 1-8" Belt conveyor with drive for cake discharge from Disc filters
4—Slurry Tanks 7' Diameter x 8' deep Filtrate Receiving Tanks and Air separator Tanks for above vacuum filters
1—Tank for acidifying filtrate (Leg Tank)
1—Flow Meter Recorder (Brown)
2—Rubber Lined Acid Tanks—12000 Gal.
1—15000 Gal.
2—Hardinge 30 ft Diameter x 7 ft Deep Clarifiers

1—Hardinge Direct fired parallel flow 80" Diameter x 60' long. Class XH—12 Dryer with 14" Screw Feeder Complete
2—6' x 50' Louisville Steam Tube Dryers
1—Buell Dust Collector No. 34 Type AC-750 Cyclone

The above equipment is still installed and in excellent condition. Motors, piping, conduit etc for this equipment are also available, and all of the above items can be inspected at the address below—

Inquiries should be addressed to

T. R. Banks, Vice President
Hershey Estates (Extraction Division)
Hershey, Pa.

Premier 6" and 10" COLLOID MILLS
Abbe 1½ gal. and 200 gal. DISPERSAL MIXERS
Sharples type M-12-161 H CENTRIFUGE
Patterson Gyro-Centric Screen, complete.
STAINLESS STEEL jacketed kettles 100 gal. and 55 gal. at 90 psi.
Day #2 Cincinnatus Sigma Blade MIXER 20 gal.
W & P lab Sigma Blade MIXER 1 gal.

IRVING BARCAN CO.
249-51 Orient Ave. Jersey City 5, N. J.
DElaware 2-6695-6

SURPLUS EQUIPMENT

FOR SALE

125 gal. full-jacketed, open kettle, hinged cover, heavy-duty double motion agitator. Three inch bottom flush valve. All internal parts 316 Type stainless steel. U.S. Varidrive unit with 7½ h.p., 220/440, 60 cycle, explosion-proof motor.

Ideal unit for mixing heavy creams, etc. Used for a short time on pilot plant work.

The Warren Development Corp.
P. O. Box 229, Hackettstown, N. J.

UNUSED
STAINLESS STEEL TANKS
IN STOCK

2—10,500 Gal. Horizontal T-304, Dished heads, 3/16" thick
2—5700 Gal. Horizontal
1—5200 Gal. Vertical
2—4500 Gal. Vertical T-304
1—3000 Gal. Vert.-Mixing
1—2800 Gal. Horizontal T-304
2—2000 Gal. Vertical T-304
4—1000 Gal. Vertical T-304
5— 500 Gal. Vertical T-304

PERRY
1413-21 N. 6th St., Phila. 22, Pa.
POplar 3-3505

DECEMBER SPECIALS

Stokes Vac. Shelf Dryer 18 shelves 40" x 44"
Devine Vac. Shelf Dryer 6 shelves 40" x 43"
Pfaudler Glass Kettles S.S. agitator 3 HP exp. mts.
3—20,000 gal. steel tanks, welded, dished heads
Pfaudler SS Reactor, 125 gal., jktd. & agtd.
Nash Hytor Vac. Pump #6, with 40 H.P. motor.
Tolhurst 40" Cent. Plough & bottom dump.
Sweetland #5 SS Filter, 20" leaves, on 3" cent.
Patterson Porcelain lined Pebble Mill 6' x 8'
Mikro Mill #281, serial 5403, with extra head.
Roto Louvre S/S 5'x26' Rotary Dryer, complete
Gen. American 42" x 120" Twin Drum Dryer
3 Vibrating Sifters 20"x72", with motors
2 W & P Heavy Duty Jktd. Mixers, 15 gal. 15 HP
W&P 100 gal. SS mixer, sigma arms, 20 HP exp.

NEW—STEEL & S/S MIXERS, TANKS & KETTLES
Fabricated To Your Specifications. Engineering Advice Available.

WE BUY COMPLETE PLANTS OR SINGLE UNITS
WHAT HAVE YOU FOR SALE OR TRADE?
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EQUIPMENT CLEARING HOUSE, INC.
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SOuth 8-4451—4452—8782

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BRAND NEW AIR EJECTORS

(Twin Stage Tubejet Air Pumps)

Applicable for Surface Condensers from 400 to 8000 Square Feet.
Priced at a fraction of their present cost.
Full details and Performance Data available.

J. A. DOUGHERTY
P. O. Box 90 - Bala-Cynwyd, Pa.

PIPE 1/8" thru 30"

FASTER THE FOSTER

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Large Warehouse Stocks

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Modern Rebuilt Machinery

UNION Rebuilt Machinery Established 1913

Reduced for Quick Sale

2—Pneumatic Scale Co. Cartoning Units, consisting of Automatic Carton Feeders, Bottom Sealers and Top Sealers. 50 per minute.

1—Mikro Pulverizer with 40 HP motor and complete auxiliary equipment.

Stokes, Day, New Era, Hottman Mixers, from 2 to 450 gal., with and without jackets, single, double arm agitators.

Baker Perkins, Day, Readco Heavy Duty, 1 qt. to 160 gals., Double Arm Jacketed Mixers, with Sigma or Fishtail Blades.

4—Fitzpatrick Stainless Steel Comminuters with 7½ HP motors and with Vibrator Feeders.

4—Scandia Practically New Automatic Cellophane Wrapping Machines, Model SFS-6F, with electric eyes.

1—Hayssen Model 10-20 Wrapping Machine, with electric eye.

Pony M, ML, World, Ermold, Pneumatic Semi and Automatic Labelers.

Day, Robinson, Tyler Hum-mer, Great Western, Gayco, Raymond Sifters.

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TOP PRICES PAID FOR YOUR SURPLUS EQUIPMENT

UNION STANDARD EQUIPMENT CO.

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RAISE YOUR PRODUCTION TO A NEW HIGH LEVEL WITH FMC EQUIPMENT

Send for FIRST FACTS Just off the PRESS

Mojonnier Stainless Steel Vacuum Pan; 6' x 12' with S.S. Condenser Coil.
Four Stainless Steel Horizontal Tanks; 6' x 34'; 7000 gal. Dished Heads.
Blaw Knox Stainless Steel Resin Still or Autoclave; 7'6" x 7'6"; Jacketed.
Two Stainless Steel 5000 gal. Pressure Tanks; 10' x 6' with Agitators.
A. O. Smith Type 347 Stainless Autoclave; 1500 lb. ASME; 1200 gal. Agitated.
Stainless Horizontal Oval 4' x 6' x 21' Tank; Milk Type; 3500 gal. capacity; like NEW.
A. O. Smith Stainless Lined 20,000 gal. Pressure Tanks; 10' x 30'.
5000 gal. Heavy Duty Aluminum Tanks; 8' x 12' Vertical ASME Heads.
Pfaudler Glass Lined Jacketed Reactors; 500-1000 gal.
Lancaster Stainless Lined Rotary Reactor; 1700 gal. 300 PSI ASME; 50" x 17'4".
Western Precipitation Holo-Flight Desolventizer or Chlorophyll Extractor.

Inquire about Classification P4. Complete plants available for nearly every product. What do you want to make?

Rotary Cutters by Abbe, Ball & Jewell, from Lab. Size to Size No. 1-15 HP.
Mikro Pulverizers from Bantam size in Stainless up to No. 4 Model.
Raymond, Williams, Gruendler, Hammer Mills for heavy duty; all purposes.
Fitzpatrick Model K 7 Comminutating Mill in Stainless with 20 HP motor.
Patterson Buhrstone Lined Model D Pebble Mills; 6' x 5' and 6' x 8'.
International Porcelain Lined X24 Pebble Mills with 50 HP Gear Motors.
Gates Tube Mills 5' x 22' with manganese steel liners.
Hardinge Conical Ball or Pebble Mill; 10" x 36"; Silica Block Lining.
Sperry 36" ALUMINUM Filter Press; 33 Chambers; 4 eye with Hydraulic Closing.
Shriver STEAM JACKETED 36" Cast Iron Filter Press; 29 Chambers.
Stainless Steel 150 gal. Vacuum Filter; 35" x 35".
Sparkler Model 33D7 Filter with Scavenger; 2000 gal. per hr.
2 Plastic Extruders Royle No. 3 and NRM 2½" Screw-Oil Heated-Controls.
Stokes Rotary Tablet Presses; RB2; BB2; RD3; DD52; Colton No. 10-35
Baker Perkins (W. & P.) Heavy Duty Double Arm Jktd. Mixers to 300 gal. sizes.
J. H. Day Cincinnattus 1000 gal. Stainless Steel Mixer; Jktd., 75 HP motor.
Readco 750 gal. Double Sigma Arms Jacketed Mixer with Vac. Bowl; 200 HP.
Werner & Pfleiderer 1200 gal. Universal Mixer; Sigma Arms; Jktd., 150 HP.
Bird Continuous Conical Bowl Centrifugals; 18" x 28" and 36" x 50" Compl.
A. T. & M. 26" Stainless Steel under driven Centrifuge; perforate basket.
Tolhurst 40" Rubber Covered Suspended Centrifugals with Monel Plows.
Sharples H2 Nozzlejector with 15 HP Explosion Proof Motor; 1000 GPM.
Sharples C27 Super D. Hydrator; Type 316 Stainless; 30 HP Expl. Motor.
8 Stainless Steel Heat Exchangers or Condensers up to 1000 sq. ft. surface.
Barnstead Stainless Steel Steam Heated Water Still; 100 gals. pr hr.
Stainless Steel Vacuum Still; 755 gal. 4'6" x 6'; coil heated.
Stainless Steel Jacketed Vacuum Still; 425 gal.; 56" x 50".
Aluminum Bubble Cap Column 60 Plates; 27½" dia. x 36'; 11 Sections.
Zaremba Double Effect INCONEL Evaporator with Calandria, 430 sq. ft.
Buffalo Fractionating Column with Still Pot; Column 42" x 24'9" with 28 Bubble Caps.
Lummus Copper Alcohol Recovery Column; 18" x 21'; 5 sections.
Barnstead Stainless Steel Steam Operated Water Still; 100 gal. per hr.
Double Drum Dryers with Accessories; 28" x 60"; 32" x 72" and 42" x 100".
Raymond 2 Stage Flash Drying Installation in Type 316 Stainless Steel.
Hersey Rotary Gas Fired Counter Current Atmospheric Dryer; 5' x 26'; S.S.
Squier Stainless Clad Rotary Atmospheric Dryer; 30" x 20'; Hexagon.
Stokes Jacketed Rotary Vacuum Dryer; 34" x 10' Model 59 AB; accessories.
American Two Door Jacketed Sterilizers; all sizes up to 36" x 42" x 84".

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OVER 5000 UNITS IN STOCK

FIRST MACHINERY CORP.

209-289 TENTH STREET, BROOKLYN 15, N. Y.

FRED FIRSTENBERG
President

PARKING ON THE PREMISES
PHONE: STerling 8-4672

Cable
"EFFEMCY"

Here is the Gelb Girl For November 1957

Due to an unfortunate series of circumstances the advertisement of R. Gelb & Sons, Inc., Union, N. J. did *not* appear in the November 1957 issue of Chemical Engineering.

The Gelb Girl was missed by her admirers.

In order to complete the full twelve months of Gelb Girls, the November selection is shown here.

Our apologies to our many friends who wrote, wired or phoned us about this omission.

R. GELB & SONS, INC.

U. S. Rte 22 Murdock 6-4900 Union, N. J.

NEW AND GOOD-AS-NEW EQUIPMENT

1—Stainless Tank #430 Chrome, vert. 7' x 10' deep.
20—Jacketed Kettles—Stainless, Copper, Aluminum.
1—Day Mixer, steam jacketed, 50 gal. Sigma Blade.
1—Sperry Filter 42", open del. 40-plates, 41-frames.
60—New Pressure Cookers, 18" x 18" & 24" x 28".
1—New Glass Nash Centrifugal Pump, 160 gpm.
1—New Nash Vacuum Pump Type AL-572.
1—Buflovak Jacketed Impregnating Tank 42" x 52".
1—Stedman Disintegrator size 40-6.
1—Jeffrey Vibrating Conveyor 12" x 6", 15' lg.
1—Nash Air Compressor, Type AL 623.
1—Manton Gaulin Stainless Homogenizer 125 gph.
1—I&R Vacuum Pump, 5 H.P., 60'.
4—Heat Exchangers, 12" dia. 11' lg., 43 steel tubes.
1—Raymond 8" Hammer Mill, like new.
2—Louisville Steam Tube Dryers 6' x 35'.
1—New Louisville Continuous Filtering Machine.
S. S. Closed Tank with Coils & Agitator, 1000 gal.
S. S. Closed Tank, jacketed with Agitator, 150 gal.
1—#316 Stainless Reactor, 265 gals. cap., jacketed.
Abbe Pebble & Tube Mill 5' x 22'—Buhrstone Lined.
1—Patterson Ball Mill, porcelain lined, 17" x 27".
1—Patterson Ball Mill, 42x36 jacketed.
2—Large Steam Jacketed Horizontal Mixers.
2—Ribbon Type Mixers, 50 & 90 cu. ft.—like new.
1—Davidson Vacuum Pump, new, 9 x 12 x 12.
2—Ball & Jewell #2 Cutters with 75 H.P. Motors.
1—J. H. Day 3 roll Mill 10 x 16.
3—3000 gal. Jacketed Kettles with Turbo Agitators.
1—#10 Day 300 gal. Jacketed Sigma Blade Mixer.
4—New Heat Exc. 60' with Cupro Nickel Tubes.
1—Sparkler Stainless Filter Model 33-S-9.
3—4' x 8' Shaker Screens.
6—W & P Mixers, jacketed, heavy duty, sigma blade 300 gal. with hydraulic dumpers.
3—Baker-Perkins Mixers—same as above.
2—Sperry 30" Filters, clsd. del. 39-pl. 40 fr.

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1—10' x 20' Aluminum Bronze Horizontal Tank, 3/16" Shell, ¼" Head. Purchased New 1954. Price $4500.00.

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138 CFM	100 PSI	7x7 Ing. ESI
234 CFM	100 PSI	9x9 Ing. ESI
268 CFM	500 PSI	10-4½x10 Ing. XOB
368 CFM	100 PSI	12x10 Ing.—Penn
465 CFM	100 PSI	12x11 Penn-Gardner
528 CFM	100 PSI	14x12 Ing. ERI
585 CFM	100 PSI	15-9½x12 Ing. XRE
590 CFM	100 PSI	13½-8x8 Penn DE2
676 CFM	100 PSI	15-8½x12 Worth
686 CFM	100 PSI	14x13 Worth HB
866 CFM	100 PSI	17-10x12 Chic. OCE
870 CFM	125 PSI	17-10½x12 Ing. XRE
877 CFM	100 PSI	17-10½x14 Ing. XRB
1007 CFM	110 PSI	19-11x12 Chic. OCB
1200 CFM	40 PSI	10x13 Ing. ESI
1292 CFM	Vacuum	22x8 Ing. ES
7950 CFM	200 PSI	33-17½x27 Ing. PRE 3-60-2300 (3) available

Portables 60-600 CFM Rotary or reciprocating.

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THE GELB GIRL—DECEMBER, 1957

CENTRIFUGES:

1—AT&M 42" Suspended Type Centrifuge, complete with Type 347 Stainless Steel Perforate Basket, Plow and Curb, with 40/20 HP motor.
1—Fletcher 40" Suspended Type Centrifuge with Type 316 Stainless Steel Perforate Basket, Plow and Solid Monel Curb, 15/7½ HP motor.
1—Tolhurst 32" Suspended Type Centrifuge with Stainless Steel Perforate Basket, Plow and Curb, 25/12½ HP motor.
1—Hercules 60" Rubber covered Center Slung Centrifuge with Perforate Basket, complete with motor and plow.
1—AT&M 28" Center slung Centrifuge with Rubber-covered perforate basket and 3 HP motor.
1—Tolhurst 32" Suspended Type Centrifuge with Imperforate Basket.
2—Sharples Type 316 Stainless Steel Centrifuges, Model D-2 (New)

DRYERS:

1—Stainless Steel Rotary Dryer, 4' x 20'.
3—Link Belt Steel Roto Louvre Dryers, Model 207-10, 310-16 and 502-3.
1—Stainless Steel Rotary Dryer, 3' x 12', complete.
2—Louisville Rotary Dryers, 6' x 45', complete.
2—Columbia Engineers Rotary Dryers, 6'4½" x 45', complete.
2—Louisville Rotary Steam Tube Dryers, 6' x 50', complete.
1—Bartlett & Snow Rotary Dryer, 4'6" x 36'6".
1—Stokes Stainless Steel Rotating Vacuum Dryer, 6' x 10'.
1—Stokes Double Drum Dryer, 5' x 12'.

FILTERS:

1—Oliver Horizontal 3' Pilot Plant Filter, New.
1—Sparkler Stainless Steel Jacketed Filter, Model 14S8.
1—Bird Continuous Centrifugal Filter, Model 24" x 38".
1—Sweetland #7 Filter with 20 steel leaves.
10—Sweetland #12 Filters with 72 Stainless Steel Leaves.
1—Feinc Stainless Steel Rotary String Filter, 3' x 3' (New).

AUTOCLAVES, KETTLES AND TANKS:

2—Pfaudler 1500 gal. Type 316 Stainless Steel Jacketed Reactors with agitators, drives and motors, 50# Jacket Pressure.
1—Pfaudler 1500 gal. Monel Jacketed Reactor, with agitator, drive and motor, 50# Jacket.
3—Stainless Steel Jacketed 2000 gallon Kettles.
1—Stainless Steel Jacketed 400 gallon Kettle with Turbo Agitator and drive.
2—Pfaudler Glass-lined Series R Jacketed Reactors, 1000 gallons ea.
1—Pfaudler Series XL Glass-lined Jacketed Kettle, 1000 gal. capacity.
1—Pfaudler Glass-lined Jacketed Kettle, Series ELL, 750 gal. capacity.
1—Pfaudler Glass-lined Jacketed Kettle, Series ES, 100 gal. capacity.
1—Nickle Jacketed 1000 gal. Kettle.
1—3000 gallon Nickle Horizontal Still Pot with Reboiler.
2—2000 gallon Nickle Still Pots with Reboilers.
2—400 gallon Nickle Vacuum Receivers.
1—Combustion Engineers Steel Jacketed Autoclave, 1800 gallons, with agitator and drive, 150# Jacket, 600# internal.
1—Autoclave Engineers Type 316 Stainless Steel Autoclave, 5000# pressure, 1 gallon capacity.

MIXERS:

1—Baker Perkins Stainless Steel Double Arm Sigma Blade Jacketed Mixer, 30 gal.
1—Baker Perkins #16 TRM 150 gallon Jacketed Double Arm Sigma Blade Vacuum Mixer, 60 HP motor.
2—Baker Perkins Double Arm Sigma Blade Jacketed Mixers, 100 gallons.
3—Robinson Type 316 Stainless Steel Sigma Type Jacketed Heavy Duty Mixers, 400 gallons capacity, 60 HP.
1—Leader Stainless Steel Jacketed Horizontal Ribbon Blender, 40 cu. ft.
1—Readco Stainless Steel Horizontal Ribbon Blender, 285 cu. ft. with 30 HP motor.
1—Process Engineers Stainless Steel Jacketed Ribbon Blender, 30 cu. ft.

MISCELLANEOUS

5—Davis Engineering Type 347 Stainless Steel Heat Exchangers, 200 sq. ft. each (New).
4—Type 317 Stainless Steel Heat Exchangers, 892 sq. ft. each, 200 PSI, ASME Code.
6—Karbate 60 sq. ft. Heat Exchangers.
1—Struthers Wells Monel Packed Column, 20" x 40'.
2—Combustion Engineers Water Tube Package Boilers, 200 HP, 275# pressure.
1—Komarek Greaves Briquetting Machine with 50 HP motor.
1—Ingersoll Rand Air Compressor with 300 HP motor, 1600 CFM, 100# pressure.
1—Williams 4-roll Mill, complete.
1—Raymond 3 roll High Side Mill, complete.
2—Stainless Steel Williams Hammer Mills.
2—Mikro Pulverizers, Model #2DH.

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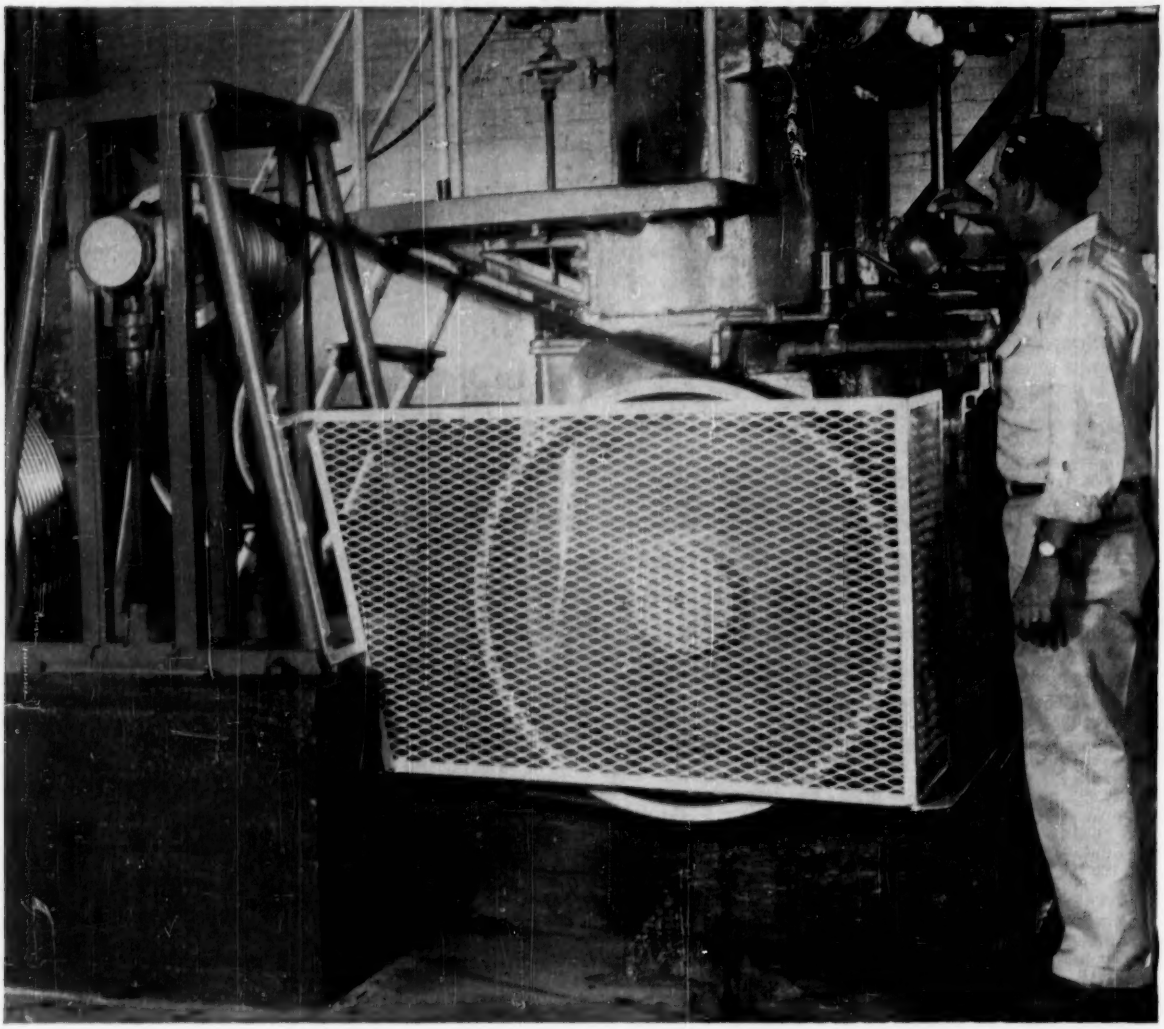
B.F.Goodrich report:



Belts used to be whipped to death

B.F.Goodrich improvements in rubber brought extra savings

Problem: Those belts look blurred because they're jumping. They're driving a compressor in an ice cream plant. The load is pulsating—which made the belts whip and tear themselves to pieces. Many belts were tried; most lasted only three or four months, had to be taken up every day; none had ever lasted a year.

What was done: When a B.F.Goodrich distributor heard of the problem, he recommended Grommet belts, a different kind of V belt developed and made only by B.F.Goodrich. On the outside a Grommet belt looks like any other V belt. But cushioned in the rubber are two cord loops, made like twisted cables except that they're endless—no splices or overlaps. It's these two grommets that makes the B.F. Goodrich belt strong enough to take sudden jerks without going to pieces.

Savings: The plant engineer doubted whether any belt could last very long on this drive, but he decided to give Grommet V belts a try. That was 18 months ago and there's no sign of wear yet. And no take-up since the first day—not one moment of attention or service.

Where to buy: Your B.F.Goodrich distributor has full information on the B.F.Goodrich V belts described here. And, as a factory-trained specialist in rubber products, he *can* answer your questions about *all* the rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Company, Dept. M-231, Akron 18, Ohio.*

Grommet—T. M. The B. F. Goodrich Co.

B.F.Goodrich

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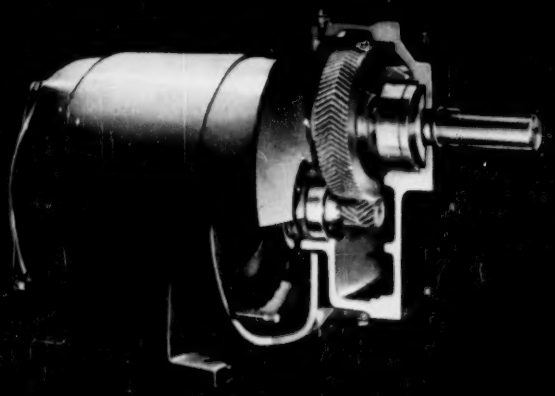

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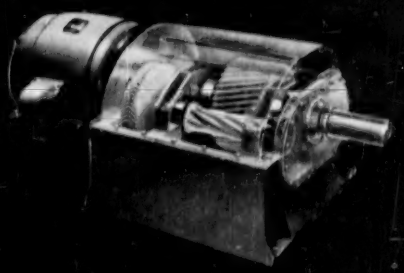
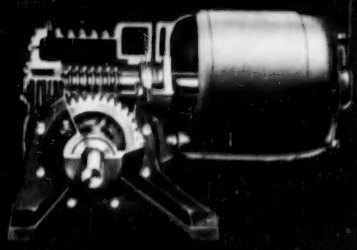
...With five types of parallel and right angle Gearmotors, Master has the flexibility and choice of design you need for selected output speeds.

...With electric motor and gears combined into a compact, integral power unit, you reduce costs and increase efficiency through elimination of belts, couplings, chains, sprockets, external bearings or separate reducers.

...Available in sizes from 1/8 to 125 H.P. You can integrate with the gearmotor electric brakes—3 types of variable speed units and fluid drive in any combination.

...And that's why more gearmotors carry the Master name than all other makes combined. Write on your business letterhead for details.





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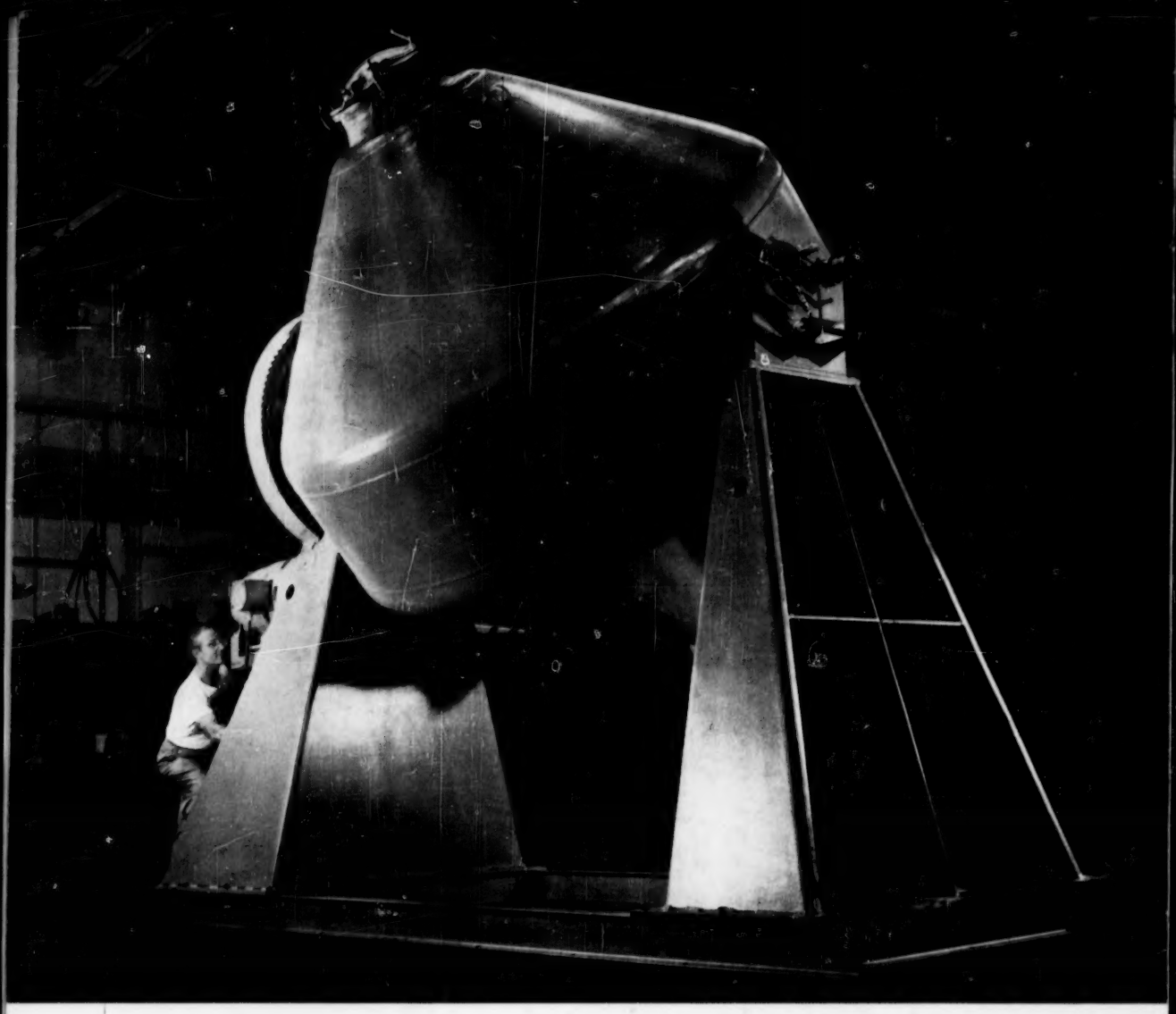

New glassed-steel dryer-blenders from Pfaudler are setting record production paces while producing more uniform blends with less labor.

Glassed steel dryer-blender cuts drying time up to 90% ...also saves labor costs, handles corrosives

By introducing product directly into the conical dryer-blender, a Midwest manufacturer found it could reduce labor costs by 50% through the elimination of intermediate handling.

Another company gets the same yield in seven hours that they used to expect from four days of vacuum tray drying. They process corrosive acid halides.

Still another company cut drying time from thirty-six hours to four, reducing by 90% the time that sensitive dyestuff intermediates are exposed to elevated temperatures.

And so the new Pfaudler conical dryer-blender continues to make its mark wherever it is used. In every case to date it produces faster, more thorough drying, more homogenous blending, both with reduced handling and maintenance.

The smooth glassed steel surfaces of the drying-blending chamber are insensitive to all corrosives except hydrofluoric acid and alkalies above pH 12 at temperatures above 212° F.

These chambers are solid, one-piece constructions which offer maximum strength and drying area unbroken by joints or clamps.

The vacuum exhaust tube is centrally located for more efficient vapor removal. And the jacket space is kept narrow and uniform for the most efficient heat transfer.

The important data on the 2-, 4-, 6-, and 8-foot diameter sizes (operating capacities up to 165 cu. ft.) are to be found in Data Sheet 26. Write Dept. CEB-127 for a copy.

THE PFAUDLER CO.

Pfaudler

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